

Tradeoffs in deliberative public engagement with science

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Originality statement

This thesis contains no material that has been accepted for the award of any other degree or diploma in any university. Publications arising from this thesis are listed on page viii. Research including primary data collection in the first case study was entirely my own work. Primary data for the second case study in this thesis was collected jointly with Professor Rachel Ankeny at the University of Adelaide. Analysis of the third case study was entirely my own work, based on primary data openly available online. Development of the tradeoffs framework was entirely my own work. Materials written by another person are explicitly referenced in the text.

Signed:

A handwritten signature in cursive script, appearing to read 'Celina Daly', with a long horizontal flourish extending to the right.

Date: 12/1/2018

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Abstract

During the last 30 years deliberative democracy and public engagement with science have developed in theory and practice to the extent that areas of consensus have emerged about good deliberative public engagement in theory. This thesis argues that in practice some areas of consensus require tradeoffs. Tradeoffs help practitioners to make decisions in design that they will otherwise have to navigate in process.

Other researchers have discussed five tensions in STS public engagement (Delgado et al. 2011); this thesis adapts three as tradeoffs. The tradeoffs are representative or inclusive participation; public or organisational ownership; and upstream or actionable outcomes. These tradeoffs are analysed through three case studies of deliberative public engagement with science in Australia.

The three case studies used two different methods of deliberative public engagement with science, namely deliberative voting and citizen's jury methods. All of the case studies were examples of invited participation, reflecting organisational ownership.

Public ownership is incompatible with invited participation, given the role of an organising sponsor or group of people who have power in designing deliberations.

Criteria for good deliberative public engagement with science can make power imbalances transparent, but organisational norms remain evident in outcomes.

Access to information varies in deliberative public engagement with science.

Organisational norms are revealed through what information is chosen as relevant in design phases. What information becomes part of a deliberative process depends on which scientists present and with which expert witnesses are available for participants to engage. In addition, communicative actions of participants during processes can

change what information participants use to develop mutual understandings. For example, in the second case study, live results of attitudinal voting were shared on a screen during deliberations. This may have influenced how participants engaged with each other. Deliberations in the third case study were organised around the report of an earlier commission, however personal narratives shared by deliberators became extra sources of information. Though much information is predesigned, communicative actions during deliberations can have impacts.

Considering what information participants bring to deliberations through their perspectives during recruitment is discursive representation. In this thesis, all three case studies were analysed for demographic representativeness. Some scholars have argued discursive representativeness is more valuable for deliberative public engagement with science. A diversity of perspectives and knowledge increases the pool of arguments with which participants can engage to develop mutual understandings. However demographic representativeness is associated with legitimacy and is easier to evaluate than discursive representativeness.

An alternative to considering representativeness in recruitment is inclusion. Full inclusion is rarely possible, given the scale of issues, so inclusion of specific groups is more typical. Engaging with specific groups can also address systemic power imbalances and ensure voices that may otherwise be left out of the public sphere are included. There is no claim to representativeness in deliberations among specific groups. Thus deliberative public engagement with science among specific groups is more valuable if iterated across multiple sites of place and time. These iterations can be linked together in a decentred deliberative democracy strategy.

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Publications arising from this thesis

- Calyx, C. and Jessup, B. (forthcoming). Nuclear Citizens Jury: From local deliberations to transboundary and transgenerational legal dilemmas. *Environmental Communication*. Taylor & Francis.
- Smith, C., & Rowe, G. (2016). Deliberative processes in practice. In *Big Picture Bioethics: Developing Democratic Policy in Contested Domains* (pp. 59-70). Springer.
- Smith, C. (2014). Public engagement in prioritizing research proposals. *SAGE Open*, 4(1), 2158244014523791.
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Acronyms

ABC Australian Broadcasting Corporation

DIISRTE Department of Industry, Innovation, Science, Research and Tertiary Education

DSTO Defence Science and Technology Organisation

EU European Union

FBI Federal Bureau of Investigation

GM Genetic modification

HTA Health technology assessment

IAP2 International Association for Public Participation

IP Intellectual property

NETS-PACE National Enabling Technologies Strategy - Public Awareness and Community Engagement

NGO Non-governmental organisation

NRM Natural resource management

OAIC Office of the Australian Information Commissioner

PNAS Proceedings of the National Academy of Sciences

SA South Australia

STEP Science and Technology Engagement Pathways

STS Science and technology studies

UK United Kingdom

UN United Nations

US United States

WHO World Health Organization

WTO World Trade Organization

Chapter One: Introduction

Deliberative public engagement with science methods have been established during more than 30 years of theoretical and practical work globally (Bauer et al. 2007). During this time two related fields of research and practice have emerged: public engagement with science and deliberative democracy. Public engagement with science is part of STS, a broader discipline with earlier heritage, as well as science communication.

Deliberative public engagement with science

Public engagement with science is underpinned by STS literature focused on publics. STS as a broader field includes anthropological studies of how scientists act (Latour 1987) and of paradigm shifts in scientific knowledge (Kuhn 1962). This thesis is focused on STS work exploring the intersection of science and society, such as Jasanoff's (1987; 2004) works on co-production and policy-relevant science. Scholars such as Wynne (1992; 2007) and Chilvers (2008a; 2009) have studied more specifically public engagement with science, a subset of STS. Their works exploring how public perspectives may differ from expert perspectives and what constitutes good public engagement shape this thesis.

Deliberative public engagement with science distinctively uses methods that involve people in developing mutual understandings through communicative action, drawing on literature from political and communications theory. Deliberative democracy theorists such as Dryzek (2000) and Young (2002) are interested in democracies that arrive at policies through communicative actions of citizens. Rather than relying on elected representatives to make decisions that may be based on opinion polling or lobbying,

mutual understandings among those affected by a collective decision are developed through deliberative processes.

Dryzek (2000) documented a deliberative turn in democratic theory around 1990. He argued that while initially deliberative methods were challenges to representative forms of governance, they became part of organisational norms. This is related to Wynne's (2007) idea of uninvited and invited participation in public engagement with science.

Deliberative democracy methods may have initially been uninvited by governance organisations, however during the last 30 years deliberative processes have increasingly become invited methods, to the extent they may now be organisational norms.

Deliberative public engagement with science methods have emerged as part of this trend towards deliberative democracy across governance.

Young (2006, p113) argued that deliberative democracy should not be centred in any particular place or authority, instead advocating for "multiple forums and sites connected to one another over broad spans of space and time". Young (2006, p43) was concerned with distribution of power, arguing for a heterogeneous public rather than one whose homogenous values and views could be established. Hayward (2008) emphasised her place as a New Zealander in analysing Young's (2002) argument for decentred democracy. She drew on Young (2006) and Dryzek's (2006) work on transnational movements as sites for decentred deliberations in studying climate change deliberations in the South Pacific. This argument for decentred deliberations addressing transboundary issues is core to later chapters of this thesis.

Dryzek and Young's works on inclusive and engaged citizenship built on Habermas's (1984) theory of communicative action, in which citizens use argumentation and reason to arrive at mutual understandings. Habermas (1989) also introduced the idea of a

public sphere, contrasted with private spheres, as the realm of our social world in which perspectives were shared and public opinions developed. Every communicative action that happens in public contributes to the stream of knowledge in the public sphere.

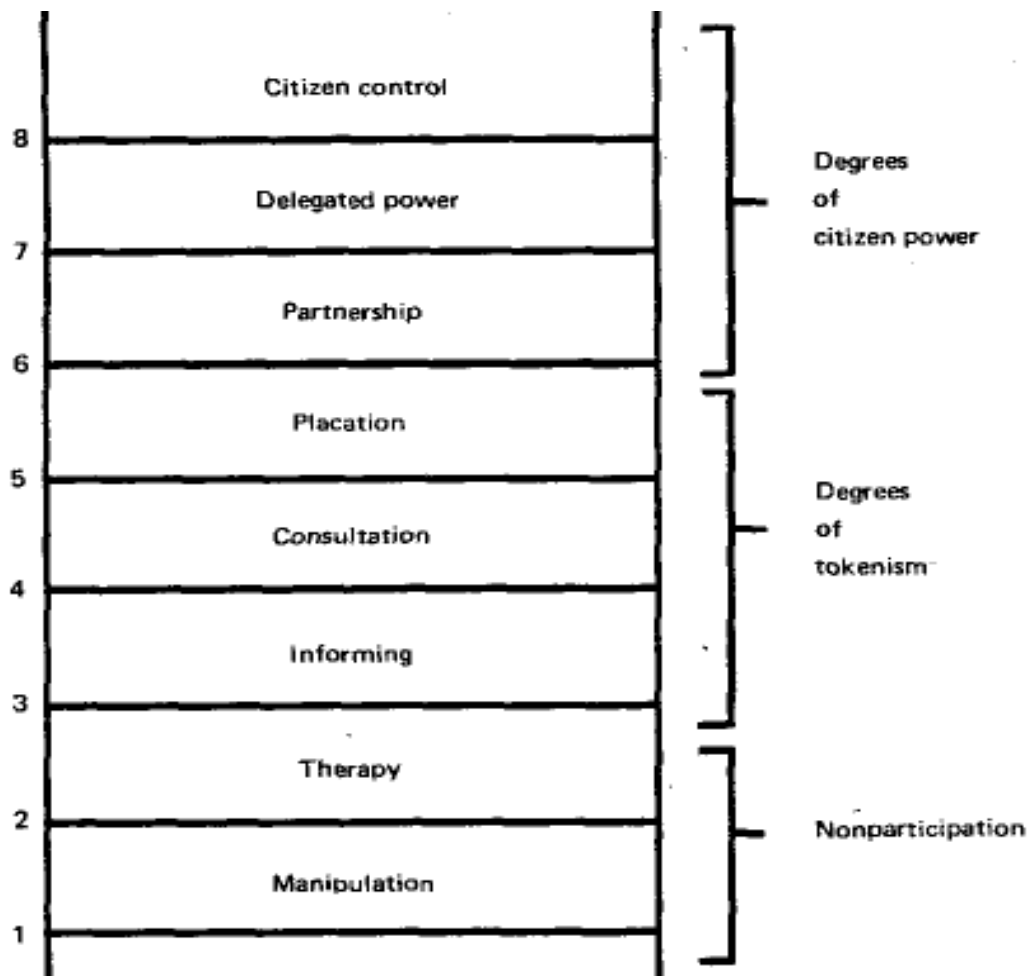
Young (2002, p170) was interested in how these streams of communication in social spaces coalesced into “bundles of topically specified public opinions” (Habermas 1989, p360). She argued this sense of *public* was a spatial metaphor, not a function, nor about the content of a perspective or opinion (Young 2002, p170). She emphasised that people could come and leave from this public discussion space, in which communicative actions continued (ibid, p171). She argued this public sphere was “the primary connector between people and power” (ibid, p173), but it was a connective stream, rather than a fixed state. This public sphere was a continuous struggle (ibid, p178) given people's’ diverse perspectives, but their communicative actions could collectively exercise power and instigate change.

Public power

Related to deliberative democracy theories are others promoting public participation in governance. Chilvers (2009, p401) defined deliberative participation using Arnstein’s (1969) ladder of participation, which predated the emergence of public engagement with science as a discipline. It was also a foundation of modern professional associations for public engagement, notably the International Association of Public Participation (IAP2). Arnstein’s (1969, p217) ladder is shown in Figure 1. This metaphorical ladder of steps in devolution of power from decisionmakers to citizens was a linear approach to defining participatory methods. Non-participation methods at the bottom of the ladder included therapy and manipulation. Above non-participation but at the lower steps of tokenism were informing methods, examples of the deficit model that will be discussed

later. Consultation and placation were midway up the ladder but still considered tokenism, with degrees of citizen control the uppermost steps. Chilvers (2009, p401) argued these upper steps of partnership, delegation and citizen control were “participation proper”.

Figure 1: Arnstein’s ladder of participation



Manipulation was having citizens on panels or in forums to educate them or engineer their support. Therapy involved citizens in methods that were more like group therapy than planning. Arnstein argued this was insidious because it involved citizens in much activity, but this activity was not about addressing systemic issues but rather promoting compliant behaviours. Arnstein (ibid, p219) gave an example of a public housing

situation in which citizens were engaged in clean-up programs rather than having concerns about security addressed. Informing is often the first step in legitimate participation, but Arnstein critiqued methods of one-way information flow, arguing citizens had no power to influence. Consultation in the form of inviting citizens' opinions is likewise a step towards legitimate participation, if accompanied by others. On its own, there is no guarantee that citizens' opinions will inform policy.

Arnstein (*ibid*, p220) argued placation was when some citizens were involved in power structures, but in ways that lacked accountability to others still excluded. Partnership, the first rung representing a degree of citizen power, meant citizens had resources to support their participation and have some community base to whom they were accountable. Delegated power was when authorities allowed citizens to make plans and policies themselves. American examples of citizen control given by Arnstein (*ibid*, p223) were akin to Aboriginal community-controlled health services in Australia (Couzos et al. 2005). In full citizen control, previously disempowered citizens were given governance and managerial control of an organisation impacting them. Arnstein (1969, p217) acknowledged that the ladder's juxtaposition of powerless citizens against powerful decisionmakers was a simplification given diverse interests in both groups, also noting there might be more rungs with less sharp distinctions in practice.

Reasons for deliberations

Three different reasons for promoting deliberative public engagement with science were articulated by Fiorino (1990) and echoed by Chilvers (2009, p402). Fiorino's survey of citizen participation in environmental risk came ahead of an influential narrative case study of environmental risk by Wynne (1992), who subsequently contributed influential theoretical work. Fiorino (1990, p227) argued there were three different types of reasons

that decisions should not be left to technocrats: substantive, normative and instrumental reasons.

Substantive reasoning for deliberative public engagement with science is based on the argument that everyday people, or laypeople, have sound judgements about risk and may see problems or solutions that experts do not. Fiorino (1990, p227) referred to regulation of the defoliant chemical Agent Orange as an example of how laypeople's risk assessments of technological hazards were sensitive to social and political values in ways omitted from experts' models.

Normative reasons relate to democratic ideals such as presented by Dryzek (2000) and Young (2002). Social and procedural justice, citizen empowerment and equity are normative principles for which deliberative democratic theorists have argued (Chilvers 2009, p402). Fiorino (1990, p228) noted that citizens expect to be able to influence collective decisions affecting them, even if they choose not to exert that influence.

Instrumental arguments are typically about increased legitimacy and quality of results emerging from deliberative processes (ibid). These can include practical arguments about increasing trust or credibility of institutions, as well as reducing the likelihood of uninvited forms of participation or conflict. However Chilvers (2009, p402) argued that these ends used to justify the means do not necessarily eventuate in practice. Evaluating instrumental arguments is challenging given they go beyond the deliberative process into societal and political impact.

Whereas normative reasons are embedded in processes and substantive reasons can be validated in what emerges from them, instrumental reasons depend on outcomes from deliberative processes. The challenges of assessing the policy impacts of deliberative

engagement have been documented (Barrett et al. 2012). This thesis uses normative arguments about deliberative and decentred democracy to justify deliberative public engagement with science. Instrumental reasons are beyond the scope of this thesis.

Deficit and distrust

In 1992 Wynne argued against what later became known as the deficit model:

“it is increasingly accepted the issues of public understanding of science, and of risk perceptions, are not so much about public capabilities in understanding technical information, but about the trust and credibility they are prepared to invest in scientific spokespersons or institutions” (p282).

This idea that public opposition to scientific applications is not necessarily based on deficits of information or understanding, but rather trust and credibility is now well established (Hansen et al. 2003; Bucchi 2008). Change in theory was so dominant it led some researchers to defend the outdated deficit model (Sturgis and Allum 2004). Counter to the broad trend of dissecting and criticising the deficit model, researchers defended its relevance in the 21st century given ongoing importance of knowledge as a determinant of attitudes toward science.

Scholars have argued for more nuanced understandings of deficit engagement models and participatory democracy. An example of the deficit model was the idea that public dissent against biotechnology was based in science illiteracy (Kurath and Gisler 2009, p562). However there has been little evidence for correlation of public ignorance about science facts with negative attitudes about science (ibid, p563). Research moved on from the deficit model to discussing what factors impact credibility, for example culture (Kahan et al. 2011) and political leanings (Kahan et al. 2012). The deficit model depended upon the idea of a public who lack knowledge and experts who have the

knowledge the public lacks, but ‘right’ knowledge claims are easily contested. Irwin (2014, p207) observed that “what might appear as dialogue to one party can look remarkably like deficit to another”.

Co-production

Jasanoff changed the field of STS in the early 2000s with the publication of two books. Both were about science and governance, relevant to policy for emerging technologies. One of the books *States of Knowledge* (2004) was about local and global frames in environmental governance. The other *Designs on Nature* was more influential (2005), popularising the idea of co-production in STS. Co-production is core to the idea of public engagement, as distinct from public awareness or understanding that may involve one-way knowledge transfer from scientists to publics, rather than two-way production of science and society. This international scope of *States of Knowledge* was reflected in a case study about African elephants in international law, and discussion of global political order. *Designs on Nature* was specifically a study of science and democracy in Europe and the United States. This focus reflected Northern Hemisphere domination of the field of STS theory.

Boundaries and networks

Another important work of Jasanoff’s for theory in this thesis was her much earlier study of boundaries in policy-relevant science (1987). This was released in the same year as the English translation of Latour’s *Science in Action* (1987), likewise concerned with the sociology of scientific knowledge. As Latour’s work on actor-network theory diffused through the English-speaking world, Jasanoff in contrast wrote not about the points in networks but rather gaps between them. Her analyses of contested boundaries and boundary-defining language used three case studies in illustration. The third of her

case studies concerned peer review, which raised concerns and questions related to the first case study in this thesis about public participation in science funding decisions. Jasanoff's and Latour's sociological enquiries about the nature of science and society three decades ago has ongoing relevance to public participation in science today.

Deliberative and decentred democracy

In addition to theories of STS, this thesis draws on deliberative democracy theory.

Deliberative democracy means decisionmaking is a product of deliberations, not only voting by representatives. Rather than voting on individuals to represent their interests, as is typical in representative democracy, citizens deliberate with each other to arrive at decisions based on mutual deliberation and collaborative learning. This political theory is behind the deliberative distinction in this thesis, focused specifically on deliberative public engagement with science. The work of political theorists in deliberative democracy such as Young (2002) and Dryzek (2000) underpin this thesis, along with law and governance theorists more firmly focused in STS, such as Jasanoff (2004).

Location of work is important in this thesis, based on Young's (2002) arguments for decentred deliberations discussed above. The spelling of Young's theory as "decentered deliberations" belies its American heritage, adapted here as decentred deliberations for an Australian thesis. Decentred deliberations happen in a diversity of places with a diversity of groups, recognising that democracy involves participation of a range of voices and perspectives.

Consensus in theory

Theoretical literature has been complemented by practical literature about what works in public engagement with science. Influential research about criteria for evaluating

deliberative public engagement was done by Rowe and Frewer (2000). They specifically focused on public participation methods that aimed to include the public in making policy. Methods they discussed included referenda, consensus conferences, citizens' juries, citizen advisory committees and focus groups (ibid, p9-10). In reviewing these methods, they developed a set of criteria for evaluating public participation methods, which they divided into criteria for acceptance and criteria for process. Acceptance criteria were representativeness; independence; early involvement; influence and transparency. Process criteria were resource accessibility; task definition; structured decisionmaking and cost effectiveness. These acceptance and process criteria were combined and organised into seven areas by Chilvers (2008a, p159). I adapted these seven areas as articulated by Chilvers into Table 1, which has been published in a book chapter (Smith and Rowe 2016, p61).

Table 1: Areas of consensus about good deliberative public engagement

Representativeness and inclusivity	Everyone interested in and affected by a decision was represented; barriers to participation and representation were removed.
Fair deliberation	Everyone was able to share their views. Interaction allowed mutual understanding between participants to develop.
Access to resources	Sufficient resources, including information, expertise and time, were provided for effective participation.
Transparency and accountability	Objectives and boundaries were made clear to participants and outsiders. How participation would inform decision making was explained.
Learning	Participants, specialists, decision makers and institutions learnt from the process.
Independence	The process was facilitated and managed in an independent and unbiased way.
Efficiency	The process was cost effective and timely.

(Smith and Rowe 2016, p61; adapted from Chilvers 2008, p159)

Chilvers (2008s, p159) claimed consensus around these criteria given that they are consistent themes in research about what constitutes good public engagement.

Learning is an uncontested area of consensus that is also an outcome from methods of engagement that are not necessarily deliberative, such as citizen science. In citizen science, non-scientists actively contribute to the generation of scientific data, through for example taking photographs of wildlife or categorising images of galaxies (Bonney et al. 2009). While citizens learn through this, they do not necessarily learn through discursive arguments and sharing of perspectives with other people, as characterises deliberative public engagement with science. Learning outcomes from citizen science may include science methods such as modelling, gathering evidence and testing ideas (Jordan et al. 2012, p307). These may not involve any interaction with other people. When citizen science does involve interaction with others it can generate collaborative learning outcomes such as building social capital (ibid, p308), reflecting outcomes of deliberative public engagement with science. Citizen science may be described as co-production, in the sense of producing data in cooperation with scientists. However co-production is understood theoretically in STS to refer to how society and science shape each other, normatively as well as in practical senses (Jasanoff 2004). Deliberative public engagement with science is co-production not because it generates scientific data (although it does not preclude this), rather because it is communicative action at the interface of science and society. This thesis is about public engagement with science that promotes values of citizenship specifically through deliberative processes, which involve collaborative learning.

The closest to contesting the consensus about the value of learning are arguments contesting what types of learning should emerge from public deliberations about

science. Jasanoff (2003, p240) argued for four “technologies of humility”: framing, vulnerability, distribution, and learning. Framing relates particularly to transparency and accountability in Table 1 and will be discussed in Chapter Four. Vulnerability is a concern for representation and inclusion in Table 1, specifically inclusion. Inclusion is presented as a tradeoff with representation in Chapter Three, related to vulnerability concerns. Jasanoff described vulnerability as including history, place, and social connectedness (ibid, p241) as well as demographic characteristics. Distribution was concerned with making sure participation went beyond ethics committees sitting on top of policymaking ladders, to upstream deliberations about distributive justice (ibid, p242). This relates to fair deliberations in Table 1. Framing, vulnerability and distribution preceded and informed Jasanoff’s concerns about learning. For example, she argued “capacity to learn is constrained by limiting features of the frame within which institutions must act” (ibid). She maintained the consensus that learning is a positive outcome of public participation, but was concerned with who was expected to learn and about what.

Whereas citizen science might be focused on publics and scientists learning more about galaxies or proteins, deliberative public engagement with science might be focused on learning about organizational values. Learning science facts in the process of arriving at policy priorities may be accompanied by learning about alternative perspectives about the value of those facts, or realising that some types of knowledge are not represented in a process at all. Jasanoff concluded that learning is a suitable objective of civic deliberation, but she argued that learning should go beyond monocausal explanations to “designing avenues through which societies can collectively reflect on the ambiguity of

their experiences, and to assess the strengths and weaknesses of alternative explanations” (Jasanoff 2003, p242). This objective will be revisited in conclusion.

Criteria for good deliberations indicate suitable designs for these avenues. As well as Rowe and Frewer’s (2000, p12) and Chilvers’ (2008a, p160) criteria discussed earlier, Webler’s (1995) criteria for deliberative discourse are noteworthy for their detail, as well as being foundations for Chilvers’ more concise criteria. Webler grouped 25 sub-criteria for evaluation under two headings: fairness (p62) and competence (p65).

Themes under both headings in Webler’s sub-criteria included participants’ equal access to information and knowledge; time to understand and deliberate; ability to access scientific and experiential knowledge; and procedures for understanding value differences (Chilvers 2008a, p160). These themes that reappear across different lists of criteria of good practice by different authors are ways to design the avenues Jasanoff (2003) envisaged for technologies of humility.

A more recently published criteria framework was Dietz’s (2013, p14083) design principles for public participation. While criteria discussed earlier appeared in STS books and journals, Dietz’s list was published in the Proceedings of the National Academy of Sciences (PNAS) of the United States of America. This article was targeted at those in the natural or physical sciences rather than those in the social sciences who may already be familiar with STS concepts. The article explained to PNAS readers that though values can be a term used informally, “values are a well-developed and well-researched concept in the social sciences” (ibid, p14081). Dietz then argued that science communication usually focuses on facts, not on values, drawing on similar arguments about the deficit model discussed earlier. Arguably due to the science audience for the article, Dietz’s principles, shown in Table 2, embed the assumption that agencies

organise public participation. This is in contrast with STS scholarship about uninvited versus invited participation and the potential for non-experts to initiate meaningful deliberations about science and its applications (Wynne 2007).

Table 2: Design principles for public participation

Agencies should proceed with:

- i)* Clarity of purpose
- ii)* Commitment to use the process to inform actions
- iii)* Adequate funding and staff
- iv)* Appropriate timing in relation to decisions
- v)* Focus on implementation
- vi)* Commitment to self-assessment and learning from experience

The process must be

- i)* Inclusive
- ii)* Collaborative in problem formulation and process design
- iii)* Transparent
- iv)* Based on good-faith communication

The process must attend to uncertainty by:

- i)* Ensuring transparency of decision-relevant information and analysis
- ii)* Paying explicit attention to both facts and values
- iii)* Promoting explicitness about assumptions and uncertainties
- iv)* Including independent review of official analysis and/or engaging in a process of collaborative inquiry with interested and affected parties
- v)* Allowing for iteration to reconsider past conclusions on the basis of new information

(Dietz 2013, p14083)

These design principles overlap with areas of consensus presented in Table 1. Dietz's first two principles, clarity and commitment, relate to transparency and accountability in Table 1. Adequate funding and staff is part of access to resources, while timing is listed as a distinct principle. Commitment to self-assessment reflects the learning criteria from Table 1. Notable in Dietz's principles is the assertion that agencies proceed with the first group of criteria. This emphasis on organisational rather than public ownership

supports instrumental arguments for public participation, to improve trust and credibility in organising agencies.

Dietz's procedural principles reflect Table 1, particularly those of inclusiveness and transparency. Being collaborative in problem formulation and process design was listed as a procedural criterion, reflecting the need for deliberative processes to involve collaborative learning and mutual argumentation. This is challenging for processes with strong organisational ownership, as is implied by Dietz's focus on implementing agencies. Being based on good-faith communication is an aspect of fair deliberations in Table 1. These process-oriented principles listed by Dietz were followed by several explicitly about dealing with uncertainty. This focus on uncertainty differed from Chilvers (2008a) and Rowe and Frewer's (2000) earlier criteria and suggests these design principles are for upstream engagement. However, being explicit about assumptions and uncertainties is part of transparency and accountability in Table 1; it is specifically the focus on iteration and review that differ. Including this list of criteria highlighting iteration and review is relevant to the normative argument for decentred democracy presented in this thesis.

Tensions in practice

In contrast to lists of ideal criteria, other STS researchers have discussed tensions in ideals for evaluating deliberative public engagement. Delgado et al. (2011) highlighted five tensions, three of which are explored as tradeoffs in this thesis. Different emphases in different criteria lists indicate that rather than being practical ideals or areas of consensus, as Chilvers (2008a, p159) suggested, these criteria are views reflecting different priorities, albeit views based on literature and research.

“While different views coexist in theory, tension between them becomes acute during the shift into practice when choices must be made in concrete terms” (Delgado et al. 2011, p828). They argued for five particular areas of tension in translating theory to practice. They discussed frustrations with attempting to meet these ideals in practice, finding some were in reality contradictory. “Frustration stems from the existence of competing demands in the attempt to move theoretical ideals into the realities of practice” (Delgado et al. 2011, p826).

Five tensions in STS and public engagement as a conceptual map were first presented separately, while noting the five topics were interlinked and impacted each other. Following separate presentations of the tensions, researchers showed how they were entangled (Delgado et al. 2011, p828). They argued that disentangling the tensions and presenting them first separately helps to demonstrate “compromises and choices between theoretical ideals” (ibid, p828). This thesis explores the three tensions that require choices rather than compromises, framing them based on this forced choice as tradeoffs.

Five “topics of tensions” were framed as questions (Delgado et al. 2011, p826):

- 1) Why should we do public engagement?
- 2) Who should be involved?
- 3) How should it be organised?
- 4) When should it be done?
- 5) Where should it be grounded?

The first question was answered by citing Stirling’s (2008) instrumental, substantive and normative arguments discussed earlier in this chapter. The tension they describe

from competing rationales is not analysed as a tradeoff in this thesis, given that multiple reasons can be used to argue for deliberative public engagement with science.

The first tradeoff presented in this thesis relates to the second question of who should be involved. This thesis argues that in practice, deliberative public engagement with science is a tradeoff between representative and inclusive participation. This will be explored in detail in Chapter Four. Delgado et al. (2011, p832) stated that “clearly the direct involvement of all members of the public in techno-scientific development is not feasible” and thus they discuss how to define a relevant participant. Jasanoff (2003) was cited as rationale for this statement, with no further justification. This thesis argues that direct involvement of all members is possible in theory and potentially also in practice, if issues are deliberated at a local scale as part of decentred democracy. Thus inclusion and representation is presented as a tradeoff in Chapter Four, entangled with whether an issue is being deliberated at a local or transboundary scale in Chapter Seven. Jasanoff’s work (2003) was used to claim that inclusion is not feasible in techno-scientific development (Delgado et al. 2011, p832). However Jasanoff did not argue this; rather she discussed barriers to effective participation.

“People may not possess enough specialized knowledge and material resources to take advantage of formal procedures. Participation may occur too late to identify alternatives to dominant or default options; some processes, such as consensus conferences, may be too ad hoc or issue-specific to exercise sustained influence. More problematic is the fact that even timely participation does not necessarily improve decision-making.” (Jasanoff 2013, p238).

The same work can conversely be understood to promote inclusion, given how Jasanoff framed vulnerability. She argued that through participation in analysis of their vulnerability, citizens could “regain their status as active subjects, rather than remain

undifferentiated objects in yet another expert discourse” (ibid, p241). In contrast to exploring tensions on who is a relevant participant (Delgado et al. 2011, p832), this thesis argues that all participants are potentially relevant, depending on whether inclusion or representation is prioritised and what methods are used for participation. Methods that include consideration of who is included and whether voices are missing are consistent with Jasanoff’s conception of technologies of humility.

The third of the questions Delgado et al. (2011, p833) presented as a tension was how public engagement should be organised. Wynne’s (2007) idea of invited or uninvited participation was used to address this tension. Invited participation are the types of deliberative public engagement methods discussed in this thesis, while uninvited participation was methods of social activism such as protests and boycotts. Delgado et al. (2011, p833) also described these as top-down organised processes versus bottom-up grassroots phenomena. Wynne had argued:

“participatory action and evaluation, of things like ‘representativeness’, especially as invited participation, never gets to address what research questions come to be seen as salient, with what imaginations of human ends and possible outcomes.” (Wynne 2007, p106).

This indicates that rather than simply being concerned with who participates, this question of organisation relates to what is discussed. The second tradeoff explored in this thesis is not about tension between invited and uninvited participation but between organisational or public ownership, discussed in depth in Chapter Five.

Wynne was more interested in the “problem of assessing options not taken” (ibid, p106) than whether deliberative processes had changed attitudes or understandings. Wynne argued that invited forms of engagement, which are intended to influence policymaking,

have preordained agendas and framing, while uninvited independent ones typically have a framing that challenges unacknowledged norms of the policy agenda (ibid, p107).

Whereas Delgado et al. (2011) were concerned with who initiated a process, this thesis is more concerned with who has power in a process. Researchers exploring the potential for invited processes that were not top-down questioned its practicality (Powell and Colin 2009). However they noted what factors indicated meaningful citizen engagement, which are explored in Chapter Five.

The fourth question of when to do public engagement discussed upstream, midstream and downstream engagement. The fifth question of where it should be grounded was about whether public engagement should be universal or context specific. These two final questions shape the third tradeoff presented in this thesis: between upstream and actionable outcomes, which will be elaborated in Chapter Six. Tension “between democratic openness and technocratic closure” was presented in the first tension about why we do public engagement (Delgado et al. 2011, p831). However in this thesis, it is presented as relevant to this third tradeoff related to actionable or upstream outcomes.

Where public engagement sits on a linear trajectory of science development from upstream to downstream engagement relates to where it happens geographically. For example, synthetic biology developed in the United States is a more downstream issue there than in Australia, where upstream questions are appropriate for the same technology because it has not yet reached Australian shores. This thesis argues for the relationship between the fourth and fifth questions of Delgado et al. (2011, p826): when should it be done? Where should it be grounded? Upstream engagement is temporally broad, while universal engagement is geographically broad.

Context specific deliberations can be considered local either in a geographical sense or in a temporal sense. This is related to Young's (2006) argument for decentred deliberative democracy, which involves multiple forums connected over space and time. In contrast to the tension of universal or context specific public engagement discussed by Delgado et al. 2011 (p835), this thesis explores local and transboundary framings of a topic as a tension in Chapter Seven. These framings are not presented as a tradeoff in design, like upstream or actionable outcomes. Rather local and transboundary framings are inevitable tensions, as this thesis argues, which suit different methods and tradeoffs.

Temporal considerations in deliberative public engagement with science are important criteria for evaluation, even though they may be beyond the control of organisers.

Wilsdon and Willis (2004, p22) argued that public engagement with science needed to move upstream because downstream deliberations ignored fundamental questions around ownership, control and to what social ends technologies were directed. However deliberative democracy theory normatively values iterations of engagement. Iteration is important given that information changes over time, as do people's positions. So upstream engagement ideally should be complemented by midstream and downstream engagement. Upstream deliberations happen when uncertainty is high, so further deliberations later in technology development are warranted when new information is available. Midstream engagement involves incremental change, while downstream engagement is more action-oriented, as will be argued in this thesis.

Linking actions in policy and research to upstream deliberative public engagement is a documented challenge (Barrett et al. 2012, p188). Downstream decisionmaking processes are more action-oriented, even if that manifests as a block against action, for

example moratoria in some Australian states on genetically modified crops (Hindmarsh and Parkinson 2013).

Northern diffusion

Miller (2001, p115) argued at the turn of the century that public understanding of science was at a crossroads, framing British reports as indicators of this. Miller referred to a Royal Society report *The Public Understanding of Science* in 1985 and a House of Lords report *Science and Society* in 2000 as landmarks. Miller's work, which used British policy to define the discipline's crossroads, as well as current deliberative processes happening in South Australia linked to a Royal Commission (Scarce 2016), indicate colonial diffusion of knowledge and practice. This is relevant in the context of arguing for decentred deliberative democracy, advocated by Young (2002).

STS and public engagement with science have strong European roots, as well as American influences, reflected in Miller's (2001, p116) comparisons. Miller mentioned French anthropologist Latour (1987) who was an early influencer in STS. Latour's work on actor-network theory in the United States established his career; as one of his students argued: "it is always in America that French intellectuals win their *lettres de noblesse*" (Mialet 2012, p457). It is partly because bilingual scholars such as Latour publish in English that their contributions are more cited than scholars from monolingual backgrounds beyond English. Latour's influence on STS was argued by Jasanoff (2012), arguably herself the most prominent American in the field, though she noted Kuhn (1962), a fellow American who wrote about scientific revolutions and paradigm shifts, as the major influence in STS's development alongside Latour. Jasanoff's own contributions will be discussed later in this chapter.

As well as strong theoretical foundations, Europe provided practical foundations for governance incorporating public engagement with science, through models of technology assessment incorporated into governance. This emerged particularly in Denmark and the Netherlands (Schot and Rip 1997) in the last decades of the 20th century, alongside STS scholarship. A technology assessment agency likewise existed in the United States (*ibid*, p252), however the Danish and Dutch models emphasized not only on assessing potential impacts of technologies but also shaping their design and development. This focus on involving new stakeholders in design and development phases foreshadowed trends towards upstream engagement, which will be discussed later in this thesis. Influence of European models of technology assessment on Australian policy and practice are reflected in calls from Australian researchers for a local technology assessment agency (Russell et al. 2011).

Why highlight these Northern Hemisphere roots in a thesis from the Southern Hemisphere? The first case study in this thesis was an Australian adaptation of a UK process (Rowe et al. 2010). The latter two were funded by federal and state governments respectively, in a nation retaining an English monarchy in governance. Colonial impacts on Australia remain, evidenced in a referendum for a republic, which failed (McAllister 2001), as well as an earlier referendum to address discrimination against Aboriginal Australians in the Australian Constitution, which passed (Attwood 2007). Public engagement with science and deliberative democracy are ideas rooted in Western scientific-industrial democratic societies; other relevant forms of knowledge and practice coexist in parallel, such as traditional ecological knowledge and participatory action research. Such related fields are beyond the scope of this thesis, but

their relevance is highlighted given discussion in this thesis about inclusion of specific groups of people whose voices may not otherwise be considered.

Nuclear cycles

Wynne's (1992) STS work looking at the impact of nuclear fallout on English sheep farmers is pertinent to this thesis, given the third case study is about South Australia's involvement in the nuclear fuel cycle. Wynne documented how scientists and farmers used different frames and perceptions of risk to assess the impact of the 1986 Chernobyl disaster on sheep in Cumbria. Three decades after the Chernobyl disaster, the Government of South Australia is using methods of deliberative public engagement with science to consider changing the state's role in the global nuclear waste cycle. South Australia's nuclear concerns include ongoing uranium mining, but also British nuclear weapons testing on Aboriginal lands in the 1960s. The Maralinga site was declared safe by British officials in 1967, but surveys in the 1980s demonstrated otherwise, prompting further remediation work (Parkinson 2002, p77).

The lands were returned to the Maralinga Tjarutja people in 1984 (Mazel 2006, p159), however the legacy of nuclear weapons testing changed the environment irrevocably. Declarations of safety by authorities that were later proved false are an example of how perceptions of risk go beyond technocratic judgements and information provision to trust and credibility (Wynne 1992).

This history is relevant to considering who is represented in deliberative public engagement with science and power dynamics in deliberative processes. Is it appropriate that a representative sample of South Australians be deliberating about involvement in nuclear fuel cycles? Is it appropriate that the perspectives of specific

groups, such as Aboriginal Australians who have been disproportionately impacted in the past, have more power to decide? These questions indicate why deliberative public engagement with science is not only about understanding technical information, but also about trust and credibility, as Wynne highlighted in his case study of nuclear fallout from Chernobyl (1992). The term deliberative public engagement with science did not exist three decades ago, but the idea that public engagement on such policy decisions should happen was gaining momentum.

Emerging technologies

Whereas nuclear fuel cycles have emerged as a policy issue since early last century (Mudd 2005), the first two case studies in this thesis were focused on more recent applications of science. The first case study was about public participation in research funding decisions, specifically research funding for plant genomics. Wilsdon and Willis (2004, p16) mentioned genomics in their influential report advocating for upstream engagement with science. Upstream engagement happens early enough in a research and development process to be able to question normative assumptions about technologies, potentially influencing research trajectories. They were more focused on nanotechnology in their report, but noted genomics, neuroscience and artificial intelligence as areas with emerging and distinct ethical and social dilemmas.

They did not mention synthetic biology, which was on the scientific horizon then but had not yet become a reality (Cameron et al. 2014). Australia's first public deliberation about synthetic biology in 2011 was the second case study of this thesis. This second case study, which built on learnings from the first, was funded by the Australian Government through the National Enabling Technologies Strategy Public Awareness and Engagement Program (NETS-PACE), which will be discussed throughout this

thesis. The title of the program included “enabling technologies” indicated its framing (Petersen and Bowman 2012). A more precautionary framing could have been “uncertain technologies”; framing may have impacted the program’s credibility and impact, as will be discussed later in this thesis.

Placing research

Part of the value of this thesis comes from its placement in the Southern Hemisphere, given the dominance of the Northern Hemisphere in the history of STS. The three case studies all involved participants from Adelaide in South Australia; the first case study also involved participants in Canberra, Australia’s capital. While the first case study emerged from my experience participating in a deliberative public engagement with science project while working in the UK, the second and third case studies were part of Australian governance. The second was funded by the Australian Government-funded NETS-PACE program, while the third was funded by the Government of South Australia, following a Royal Commission. This indicates that public engagement with science contributes to multiple levels of governance in Australia today.

This thesis exists with others emerging from Australian scholarship related to deliberative public engagement with science, such as McKenzie’s (2014) study of values in science communication evaluation and Donald’s (2015) exploration of what a scientifically engaged Australia would look like. Donald analysed Australia’s first national strategy for engagement with the sciences in 2010, which aimed to create a ‘scientifically engaged Australia’. Her research found one-way methods reflecting the deficit model persisting in Australian practice, despite policies about more participatory methods. McKenzie (2014) studied values in science communication in Australia, inclusive of deliberative methods. She found that science communication evaluations

were influenced by competing values of stakeholders, such as the tension between participatory theory and one-way practice Donald discussed. Thus deliberative public engagement with science in Australia has been studied little so far, given it still forms a minority of science communication. Participatory methods in Australia being increasingly popular despite a majority of deficit model science communication methods reflects international trends (Metcalf and Gascoigne 2012). Considerations of deliberative public engagement with science in Australia follow a history of science communication more focused on practice than theory.

Predating case studies presented in this thesis was an Australian study of public engagement in human embryo research policy. Ankeny and Dodds (2008, p218) found that as early as 2001 there were explicit calls for public engagement about human embryo research. They discussed instrumental reasons for this public engagement, arguing governments were seeking legitimacy for regulation (ibid, p219). A workshop on nanotechnologies in the rural city of Bendigo in 2004 generated a 'community issues checklist' (Laffite and Joly 2008, p33) and was followed by a citizens' panel on nanotechnologies in Melbourne (Katz et al. 2009), both of which were early Australian uses of deliberative methods similar to those presented in case studies today. These works from more than a decade ago indicate that ideas of deliberative public engagement with science had reached Australian shores before this research began. Case studies in this thesis demonstrate that these ideas have infused both state and federal levels of government, reflecting a shift from uninvited to invited forms of participation in government science policy.

Beyond Australian shores, ideas and practices of deliberative public engagement with science can be observed in the Southern Hemisphere. New Zealand has a richer history

of this than Australia relative to its smaller population, evidenced in research a decade ago on inclusion in deliberations about genetic modification (Goven 2006). New Zealand studies predating work in this thesis covered civic engagement in biotechnology governance (Cronin 2008) and public engagement about biosolids for waste management (Goven and Langer 2009). Like Australia's English colonial nuclear history, New Zealand and Pacific neighbours were impacted by French and English colonial nuclear testing (Crawford 1998).

Nuclear testing in the Pacific involved risk assessments that were not based on sound science but rather what are now regarded as discriminatory biases, such as:

“independent authorities agree that.... only very slight health hazard to people would arise, and that only to primitive peoples” (Maclellan 2005, p363). Wynne's (1992) study of nuclear fallout risk perceptions contrasted the views of farmers with those of scientists and authorities, all of whom were regarded as people equal before the law. Colonial contexts in Oceania, in which people lacked rights to participate in decisionmaking about their lands, make questions of credibility and trust more stark. The 1985 signing of the Rarotonga Treaty for a South Pacific Nuclear Free Zone (Maclellan 2005, p366) was preceded by uninvited forms of public engagement with science, before these terms were popularised in research. Activists ran public education campaigns as well as protests at potential nuclear ports. Grassroots campaigns led to more than 65% of people living in self-declared nuclear free zones by 1984 (Meyer 1999, p197). Deliberative public engagement with science is an active area of research and practice in New Zealand, more so than Australia given relative populations.

As mentioned earlier in this chapter, publishing in English helped establish Latour's career (Mialet 2012); engaging with research and practice in South America and Africa

can be challenged by language differences. Reviewing studies published in English does not do research on these continents justice. Studies from Chile about public participation in water governance (Garande and Dagg 2005) and from Argentina about local participation in resource development (Walter and Martinez-Alier 2010) reflected public engagement priorities in resource-rich developing country contexts. Such research was framed through theories of development rather than as public engagement with science. Critical questions about public engagement and access to information about medical research in Africa were raised a decade ago (Geissler and Pool 2006). Sociological research about a vaccine trial in Gambia was entitled ‘Public engagement with science?’ (Fairhead et al. 2006). It was concerned with issues of informed consent and how people’s balancing of benefits and risks in their decisionmaking about vaccines for their children impact public health. Such studies indicate that while deliberative public engagement with science terms and established methods may have been used only in the last decade in the Southern Hemisphere, sociological questions about the roles of experts and publics in science policies were raised earlier.

Decentring and diversifying deliberative public engagement with science

Emphasising the Southern Hemisphere placement of this work and challenging areas of consensus about ideals of public engagement is in the spirit of Young’s (2001) work on activist challenges to deliberative democracy. It echoes Hayward’s (2008) emphasis of her New Zealander status in analysis of Young’s (2006) decentred democracy work. I am placing myself among public engagement professionals wary of consensus. Consensus implies a central core of knowledge and norms. This thesis argues that some areas presented as consensus are not centred, but rather multifaceted. Diversity of

perspectives increases the amount of information with which people can deliberate to arrive at mutual understandings. Decentring of knowledge is a strength, as Young argued (2002, p46).

Chapter Two of this thesis presents theory about methods and details of methods used in the three case studies, through which tradeoffs are analysed in later chapters. Chapter Three presents results of the case studies regarding who participated, how people voted and what they concluded from deliberations. All three were about controversial technologies, characterised by uncertainty, risk and opportunity. Primary data analysed from the first and second case study included outcomes of voting. The second and third case study involved analyses of transcripts from the deliberative processes. Chapter Four is concerned with the tradeoff between representativeness and inclusivity, while Chapter Five discusses public and organisational ownership. The final chapter looking specifically at the tradeoffs is Chapter Six, focused on upstream and actionable outcomes. Chapter Seven explores how these tradeoffs play out depending on whether deliberations are about local or transboundary issues, noting that all issues can be deliberated from either local or transboundary perspectives. How the three case studies were framed and how this means they fit within the framework is then presented. Finally Chapter Eight concludes by making recommendations for further research and refinement regarding the tradeoffs and areas of consensus about what constitutes good deliberative public engagement with science.

Wynne (2007, p109) outlined an intellectual and democratic program of work for STS and its sister fields, such as science communication. There were five elements of this work. The first was understanding political economic dimensions of today's techno-sciences; discussion of research funding models and state and federal policy priorities in

this thesis touch on this. The second was highlighting the normative models of publics which are enacted through cultures of science policy. Chapter Four, concerning recruitment of participants, and Chapter Five, concerning tradeoffs in public and organisational ownership, address this directly. The third was understanding expert presumptions that public concerns are known, thus excluding actual public roles. This is part of the tradeoff of organisational and public ownership, given expert design over processes claiming to find public priorities. The fourth was charting the larger diversity of different human cultures in which normative scientific discourse intervene. Placing this work in the Southern Hemisphere relates to this, though deeper consideration of the diversity of cultures present in Australia, let alone broader Oceania, is beyond the scope of this thesis. The fifth was connecting these earlier works with historical and philosophical perspectives on science as public knowledge, publics and democratic political theory. This introductory chapter has sought to provide this connection, which will be revisited in the concluding chapter.

Jasanoff (2004, p35) said it was helpful to separate STS literature into two strands - constitutive and interactional. Constitutive work is describing emergent phenomena in a stable way, building immutable knowledge. Interactional work is less concerned with what we know and more concerned with how we know. Interactional work “probes how human beings organize, and periodically reorganize, their ideas about reality” (p37).

Areas of consensus among scholars about good deliberative public engagement emerged from three decades of scholarship in theory and practice. Arguably this stable emergence of themes is constitutive, however this thesis challenges aspects of consensus about what constitutes good deliberative public engagement. Deliberative public engagement with science generates interactional rather than constitutive

literature. All deliberative public engagement with science is concerned with reorganisation of ideas, because reorganisation of ideas is core to deliberative processes.

Chapter Two: Methods

Introduction

The three case studies analysed in this thesis adapted methods of deliberative public engagement with science for use in Australian contexts. A typology of public engagement methods was established more than a decade ago and discussed the need for further research (Rowe and Frewer 2000). Different methods suit different situations; this thesis argues for tradeoffs that must be considered in the design stages of deliberative public engagement with science. These three tradeoffs are presented ordinally in the sense that the first, prioritisation between representative or inclusive participation, happens at the recruitment stage. Public and organisational ownership is a tradeoff to consider throughout the design process, however it is particularly relevant for questions about what information and what experts will be presented to participants for consideration. Upstream or actionable outcomes emerge from deliberations, however setting objectives about intended impact and choosing a process with this in mind must likewise be considered in design. Though there are diverse methods, they all involve these tradeoffs.

The case studies in this thesis are based on two methods of deliberative public engagement with science. The first two case studies used deliberative voting methods, whereas the third used a citizen jury method. Some public engagement methods are highly formalised, to the extent *Deliberative Polling* and *Citizen's Jury* were both trademarked in the United States (Fishkin and Luskin 2005; Street et al. 2014). The *Deliberative Polling* trademark was reportedly to ensure quality control, as well as raise funds for Stanford's Center for Deliberative Democracy (Fishkin et al. 2004 p63). The

Citizen's Jury trademark was reportedly designed to "preserve the integrity of the process" (Street et al. 2014, p1). Standardisation does not promote adaptation to local circumstances, so such trademarks inhibit deliberative public engagement methods being applied in other contexts. Situating a deliberative process in context is important even when using generic methods (Abelson et al. 2007). Given the evolving nature of deliberative public engagement research and practice, adaptations in response to evaluations of past deliberations is useful. For example, the method used in the first case study was adapted from a prior UK study about public engagement in research funding decisions (Rowe et al. 2010). An example of adaptation to local circumstances was limiting options to three research proposals rather than four, because in the Australian circumstance, only three scientists were available for all three replications of the deliberative process. Transparency about methods and their adaptations is an aspect of good deliberative public engagement with science.

The first and second case studies in this thesis involved voting following deliberative discussions. Deliberative polling has been described as "exposing random samples to balanced information, encouraging them to weigh opposing arguments in discussions with heterogenous interlocutors, and then harvesting their more considered opinions" (Fishkin and Luskin 2005, p287). This description is embedded with assumptions that will be unpacked in subsequent chapters, about whether random samples are appropriate and whether heterogeneity is desirable among participants. Other research described as deliberative polling likewise did not limit participation to random samples of populations. For example, what was described as a deliberative poll in Ontario about devolved decisionmaking included nonrandom participants at townhall meetings and experts in health care and social services (Abelson et al. 1995). The action of harvesting

opinions is critiqued later in this thesis, given that participants are affected by deliberative processes and taking an extractive approach to opinions for decisionmaking may limit actionable outcomes, if decisionmakers have no relationship to the process.

The second case study built on experiences from the first, but explicitly focused on an upstream issue for engagement. The second case study was Australia's first public deliberation about synthetic biology, which was also a deliberative voting process. However rather than voting on one of three options predefined by scientists, participants voted on policy priorities they had developed during the forum. Like the first case study, participants met on a single occasion, heard from experts, asked questions of experts, then deliberated in small groups, then deliberated in a large group, questioning the experts again before voting.

Unlike the first case study, in which the voting options were predefined before the forum began, in the second case study participants developed the options on which they were voting during the course of the event. I was manually typing in priorities articulated by participants as they spoke to the large group, following small-group discussions. Then participants voted on their priorities among those articulated. This live process was good for transparency but did not allow much opportunity for review of the list before voting. The MC facilitating large-group discussions asked representatives of small-group discussions to share with the large group their top priorities, asking also if there were overlaps between the groups. It is likely that the wording of a priority articulated the first time was dominant. Other groups who discussed similar issues may have used different language in their deliberations, but indicated to the facilitator they had discussed the same issues. If the same issue was echoed by another group, the second group's wording was not reiterated on the list of

priorities as a separate issue, rather the issues were amalgamated together. This also meant some priorities may have been bunched together in ways that would have differed if they were discussed in a different order. Benefits of transparency in participants seeing what they were discussing transcribed live for them to vote on may have been offset by costs of little opportunity to analyse whether the groupings of topics being discussed were optimal and whether wording reflected mutual understandings across groups.

The second case study used an e-voting technology that was a feature of the Science Exchange venue. People voted by clicking on a digital pad, rather than writing their responses on surveys as they did in the first case study. This meant there was no opportunity to gather open-ended qualitative data about why people voted the way they did, which informed analysis of the first case study. However a transcript of large-group deliberations was available from the second study, whereas in the first, deliberations themselves were unrecorded. So while the second case study was also a deliberative voting process, there were differences between the methods used in the two case studies.

In contrast to deliberative voting methods used in the first two case studies, the third was explicitly designed as a citizens' jury. This is despite the process involving more people than are typical for a jury. Some reports of citizens' juries show that 12-16 people typically participate (Lenaghan et al. 1996, p1591; Coote and Lenaghan 1997, pii), 12-25 participants were noted in a systematic review (Street et al. 2014, p2). The first Nuclear Citizens' Jury engaged 52 people in deliberations; the planned second jury will involve 350 (Your SAy 2016a). A typical contrast between deliberative voting methods and citizens juries is size. However the 52 participants in the Nuclear Citizens'

Jury was closer to the 75 participants in the second case study, or as close the 85 participants in the first case study as the typical dozen participants documented in literature about citizens' juries.

Research into citizen's juries suggested that a central problem was group dynamics; how facilitation could ensure that members had fair and equal opportunities to express opinions (Lenaghan et al. 1996, p1592). Having a greater number of participants intensifies this problem. In the case of deliberative voting, each participant has an individual vote as part of the process. In the case of a citizen's jury, which is typically more focused on achieving consensus (Coote and Lenaghan 1997, p83), opportunity for expression is further constrained. Given the number of participants in the Nuclear Citizens' Jury it is more appropriate to analyse it as an instance of deliberative public engagement than an example of a typical jury method.

In contrast to the deliberative voting methods described in the first two case studies, citizen jurors participated for four days, over two weekends. Both the first and second case studies involved participation over a period of hours, whereas the third took place over days. Implications of time for deliberations on participant satisfaction and confidence will be reported in the results section, then further analysed later in this thesis.

Recruitment methods differed between the three case studies. The first case study specifically aimed to engage people without a background in science, using elements of snowball sampling methods (Biernacki and Waldorf 1981). Although participants were selected to reflect a broad demographic mix, this mix of people came from a group who applied. It was not an entirely self-selected group given that those applying could register a table of participants, who were then contacted individually with a participant

information sheet and an invitation to participate. Allowing people to register as a group, a type of snowball sampling, drew participants who may not have self-selected to participate. The forums were marketed as targeted at those without a background in science, with people engaged encouraged to invite other friends without a background in science, to share a meal during deliberations. The social element and the meal provided were incentives that attracted people who may not self-select for civic engagement.

The second case study involved self-selection. Policymakers and those with a background in science were invited, as well as laypeople. People were invited through the Royal Institution of Australia mailing list and local media services, as well as through social networks. The forum was promoted as Australia's first public deliberations about synthetic biology; the novelty of the issue was an incentive for participation. The forum included a dinner, funded through the Australian Government grant for the project, which was another incentive.

Participants in the third case study were financially remunerated for their time. A common feature of citizens' juries is use of stratified sampling in recruitment (Crosby 1995), as was the method for the third case study. This reflects the typically representative nature of recruitment for citizens' juries, which will be discussed in the next chapter. A systematic review of citizens' juries found widespread bias despite claims of participant representativeness. However they identified six studies without evidence of bias, which all used stratified random sampling and a "substantial honorarium" (Street et al. 2014, p5). Stratified random sampling was recruitment based on a range of mostly demographic criteria, through a market research company or by

telephone, letter or door-knocking. Differing recruitment methods for the three case studies will be discussed further in Chapter Four.

Law (2004, p2) argued that social science is messy. Parts of our observations and participation in the world are able to be clearly reported, but “other parts are not, or if they are it’s because they’ve been distorted into clarity”. He argued we are missing some of the realities that are diffuse, ephemeral, or changing like a kaleidoscope, and asked whether we should know them. He then asked, if knowing is not appropriate, how should we relate to them? Latour and Woolgar (1979) observed that as well as describing realities, science produces them. Law (2004, p13) argued this multiplicity of realities called for “method assemblage”, that is “enactments of relations that make some things (representations, objects, apprehensions) present and thus others absent” (ibid, p14). He divided this into manifest absence - that is absences that are discussed - or hidden otherness, which are unknowable without tacit experience. There are instances of manifest absence in this thesis - discussion about what demographics were missing and what deliberations were not recorded. In contrast to staccato instances of manifest absence, hidden otherness pervades this work. Arguably this is true for all PhD theses, or all research work. There are issues not discussed because to do so would be to distort them into clarity. The value of transparency is articulated throughout this thesis. Thus it is important to note that some narratives and details have been left out in the process of organising the information that has survived to the final narrative of this thesis.

Background to method in the first case study

The deliberative voting method used in the first case study was directly adapted from a prior UK study (Rowe et al. 2010) about research funding decisions. The need for a

method for deliberative public engagement in research funding decisions in Australia is indicated by dissatisfaction with research funding processes (Smith 2014, p1). This method of deliberative public engagement tested a way to add value to the effort researchers put into research proposals by using these proposals as a basis for deliberative public engagement.

Methods for research funding decisions in Australia do not typically feature public engagement. Peer review is the main method for allocating grant funding, with core funding decided by formulas implemented by bureaucrats (Geuna and Martin 2003 p293). Researchers have criticised decisionmaking processes used to allocate funds for research. Recently the journal *Nature* published a critique of how much time Australians waste on grant application processes (Herbert et al. 2013). An earlier study challenged Canada's policies about how funding decisions are made (Gordon and Poulin 2009). This found it would cost the same to give all researchers a grant automatically as to continue the established process for funding decisions. Such studies suggest a need to improve processes for decisionmaking about science funding, irrespective of the push for greater public engagement with science.

Public engagement methods such as that used in the first case study could prioritise between research proposals that are not well differentiated in peer review processes. Researchers concluded that funding allocations for Australian research were somewhat random and unreliable and so, could be improved (Graves, Barnett, and Clarke 2011). They suggested an improvement may be allowing panels to classify grants into three categories: certain funding, certain rejection, and funding based on a random draw. Methods of deliberative public engagement about research proposals represent chances for public involvement to genuinely influence funding decisions. Some public

engagement is critiqued as consultation that aims to rubber-stamp policymakers' foregone conclusions (Powell and Colin 2009; Wynne 2006). Rather than focusing on the top 10% of research proposals that certainly get funding, public engagement could prioritize among those facing randomness or uncertainty in the current system. The method used in the first case study could enhance public participation in science where it may otherwise be left to chance. If randomness is arguably preferable to the current norm, then public participation could be better still, if only for enhancing participants' knowledge and experience. It would also allow scientists leading these uncertain proposals to understand public perceptions and preferences about their research. If unfunded following deliberations, future iterations of the proposal shaped by public feedback might be more successful.

The same researchers (Graves et al. 2011, p4) said anecdotal evidence suggested researchers skilled at winning funding complete most of the research before applying for funding. This goes against ideals of upstream public participation in science policy decisions (Pidgeon and Rogers-Hayden 2007; Tait 2009; Wilsdon and Willis 2004) and further indicates little opportunity for publicly-funded science to be shaped by public deliberations in the current system. The method in the first case study served as a "proof of concept" for how public participation could be used to prioritise research proposals for funding in Australia. There are many possibilities; context explaining why this method was chosen follows.

Enhancing participants' civic and scientific knowledge is typically an aim of deliberative public processes in science. In addition to academic policy reasons, outlined above, there should be practical benefits for individuals participating in deliberations, whether as scientists or laypeople. These practical benefits were drivers

for this particular experiment. Frustration of scientists at the Australian Centre for Plant Functional Genomics about the state of public dialogue about biotechnology meant they were open to participating in experiments with public engagement. So 2008 saw a shift from media-focused communications and lecture-based public interactions toward experiments with deliberative processes. These experiments aimed to demonstrate that deliberative public engagement could be useful for scientists as well as participating members of the public. The public could gain knowledge and experience with deliberative decisionmaking about science, whereas scientists could better understand other citizens' perspectives and see how their research is perceived when presented firsthand, rather than through media filters.

The UK model modified for use in Australia came from the Institute for Food Research, linked to the John Innes Centre, another centre doing plant genomics research. This connection helped to legitimise this method of deliberative public engagement as a starting point for participating scientists and management in Australia.

Method in case study one

A report of the first case study's deliberative public engagement with science process already has been published (Smith 2014a). It was explicitly modelled on a UK deliberative democratic event about prioritising research proposals (Rowe et al. 2010, p236). The method used was brief in comparison with many types of deliberative public engagement that run for more than 1 day, which may require participants to consider information before and between events. In contrast, this method took no more than 3 hours of participants' time. This has benefits for both participants and organisers, as well as shortcomings, which will be discussed later. The event format, which was repeated three times across two cities, was as follows:

- 1) 0:00 Participants arrive and have time to choose a seat, read the research project information sheet, fill in the pre-event survey, and interact with other participants.
- 2) 0:20 The facilitator welcomes the participants and introduces the project, emphasising the importance of participation and introducing the presenting researchers.
- 3) 0:25 The first scientist presents his or her proposal.
- 4) 0:40 The facilitator asks participants to discuss potential questions with each other.
- 5) 0:45 Questions relevant to the specific project are answered by the scientist; those the facilitator considers relevant to all of the projects are recorded for later.
- 6) 0:55 Repeat Steps 3 to 5 with second scientist.
- 7) 1:25 Repeat Steps 3 to 5 with third scientist.
- 8) 1:55 Questions that were recorded earlier are addressed, with each scientist given right of reply to each question, and participants given the chance to ask follow-up questions following deliberations among tables.
- 9) 2:20 The formal deliberative component is finished. Public participants record their private vote on slips of paper, which are collected by volunteers. They are asked to fill in the second survey while the votes are being counted, and to give these surveys to circulating volunteers once completed.
- 10) 2:30 After the votes are counted twice, the outcome of voting is announced. Participants are invited to stay and chat with the scientists and each other over a drink, so discussions can continue informally and unrecorded.

Differences in event methods

There were some differences in the format of the Australian and UK events. The UK version involved recorded endorsements from local celebrities for the different projects; these were not used in the Australian events as they were of limited value (ibid, p236). In Australia, three scientists presented their research plans rather than four as only three suitable scientists were available for all three events. In addition, all three presented their genuine research plans; there was no deliberately dubious research project as there was in the UK event. No-one voted for the fake project in the UK event (ibid, p234), so this aspect was excluded in the Australian model.

In the UK event, it was implied that the public vote would lead to funding for the winning project. The author of this article was a public participant at the UK event, where there were discussions among participants about the novelty of genuinely making a decision about what science is funded. After voting, it was revealed that the event was an experiment to learn what the public thought about research funding, rather than an event that would actually allocate funding based on public preferences. In the Australian events, participants were informed from the beginning that they were participating in a research project testing a model of deliberation, although the facilitator expressed hope that such pilot events could lead to genuine allocations in future. Australian participants were asked to *imagine* they would be awarding 500,000 Australian dollars to the winning project. There was no evidence about whether the deception affected the outcomes of the UK study, so it was omitted from the Australian events.

Differences in recruitment methods

In the earlier UK event participants were entirely self-selecting (Rowe et al. 2010, p229). In the UK study people were invited to attend an evening event at a city youth arts venue in Norwich to vote for a research proposal chosen among four presented by Institute for Food Research scientists. Announcements inviting participation were sent through email to approximately 1000 people through their mailing list database, as well as being advertised in a local paper and at the venue. In recruiting for the Australian deliberative events social networks were used to share information, as well as advertising in local media (Smith 2014a, p4). People were encouraged to invite friends without a background in science, emphasising it was designed for them, in line with snowball sampling methods (Biernacki and Waldorf 1981).

Snowball sampling

On registering interest, prospective participants were sent an information sheet explaining what would happen at the event and why; the preference for people without science degrees was reiterated. People with science degrees who inquired about participating were put on a waiting list. Participants were able to specify seating preferences and register to participate in a group. Allowing participants to register in groups, in line with snowball sampling methods (Atkinson and Flint 2001), drew individuals unlikely to attend such an event normally. It is probable that “seed” participants who drew others to participate were more actively or confidently involved in deliberation at the event; so although such recruitment draws a wider range of people, power imbalances in participation may have resulted. Given that snowball sampling recruits participants through social networks, isolated individuals were unlikely to be engaged using this method (Smith 2014a, p4).

Repetition and location

Another difference between the UK and Australian events was repetition: There were three in Australia across two states, compared with one event in the United Kingdom. Adelaide, the capital of South Australia, hosted the largest event, whereas Canberra, the nation's capital, hosted two smaller events at a venue with less capacity. Repetition of the method allowed the order of the Australian presenters to change on each occasion. Each presenter had the opportunity to present first, second, and last, to counter possible effects of presentation order bias. A strength of this method was countering potential biases in the design of the series of engagements, following advice of the ANU Statistical Consulting Unit. However, it is worth noting that although the same scientists presented the same research project on each occasion, there were inevitably subtle differences in each presentation and the manner in which it was presented as the presenters gained experience. Furthermore, it is likely that confidence levels among the presenters changed after the first event's vote, which may have influenced presentations and voting.

The events were held at public venues, away from where the research projects under deliberation would happen, to help foster open-ended discussion as suggested by Powell and Colin (2008). In Adelaide, the event happened at the National Wine Centre in the city centre, which is owned by the University of Adelaide but used as a public space. In Canberra, the two smaller events happened at The Front Gallery and Cafe in Lyneham, an informal venue with no research or university links, apart from hosting National Science Week events.

Research proposals presented

As in the UK event, proposals all related to agricultural and food science. In Australia, all three presented projects related to research happening at the Australian Centre for Plant Functional Genomics. Each presenting scientist reworked an existing research proposal into a 10-minute presentation (with 5-minute leeway in reality). Each had experience in public science communication and consulted with professional science communicators beforehand to ensure that information presented would be publicly accessible. The presentations and format were piloted with a local high school science class before National Science Week, after which presenters had the opportunity to tweak their presentations further.

All proposals had two things in common: They involved some research using genetic modification (GM), and each discussed at least one potential environmental benefit. The type of GM and its role in final outcomes of the research varied, as did research applications. One involved moving genes from one type of cereal into another to enhance salt tolerance. Another involved manipulating existing genes in barley known to be involved in producing beta-glucan, with applications for human health and biofuel production. Another involved investigating the genomes of different corn varieties with the aim of finding genes relevant to nitrogen use efficiency.

The presenters were selected for diversity as well as science communication talent. In contrast to the UK study (Rowe et al. 2010) only three scientists presented, as only three were available for all three iterations of the process. There was a female senior researcher, Dr Rachel Burton, who had recently published research in the journal *Science*. A male senior researcher, Dr Trevor Garnett, was leading a project with funding from a private company as well as government. A male graduating PhD

student, Darren Plett, was working on a collaborative project with the University of Cambridge. Each scientist was encouraged to share information such as the above about collaborations and past research achievements, as this type of information is used to inform decisionmaking in current funding models.

The same three scientists from the Australian Centre for Plant Functional Genomics presented their research proposals at the three events, in varying presentation order to prevent bias (Podsakoff et al. 2001). Each presenting scientist reworked an existing research proposal into a 10-minute presentation (with 5-minute leeway in reality).

During ethics approval for this project the impact on public participants was considered, however the impact on presenting scientists was not. Public participants were required to be given an information sheet and had the option to withdraw from participation at any time. The presenting scientists were involved in planning the study and committed to repeating their presentations across the three events; this was extra outreach work on top of their day-to-day work as scientists. The three presenting scientists were co-designers of this case study in practice and their participation and support was fundamental.

Survey method

Participants completed surveys before and after the events, which were designed to take 10 minutes to complete. These have been made openly available online (Smith 2013; 2014b). The pre-event survey included 15 questions covering demographics, political participation, participants' own areas of expertise, and science funding issues. The post-event survey included 13 questions asking for the participant's voting decision, their ratings of the presentations on 11 criteria, and feedback about the event. The survey

questions were designed to facilitate comparison with data from the UK event, detailed analysis of which is beyond the scope of this article.

In questions rating the presentations, survey respondents could rate all presenters the same. These ratings were used to deduce rankings in analysis. These quantitative questions were complemented by open-ended questions, notably, for example, asking why people voted for the proposal they did. Participants also filled in a separate voting slip, the results from which were announced at the end of the event. The surveys before and after were collected for later analysis.

Background to method in the second case study

Case study two was Australia's first public forum on synthetic biology, held at the RiAus Science Exchange in Adelaide on the evening of Thursday 7 April 2011. The RiAus is a charity for promoting public awareness and understanding of science, with technologies useful for deliberative democratic events such as an electronic voting system used in this study. I was employed at RiAus as Science in Society Facilitator, funded through the Australian Government, during the time of the forum. Professor Rachel Ankeny from the University of Adelaide was co-investigator of this second case study. A strength of this case study was innovation, both in being upstream as the first synthetic biology public dialogue in Australia, as well as incorporating e-voting technology into deciding priorities and making outcomes transparent.

The forum was funded by what was then the Australian Department of Innovation, Industry, Science and Research as part of the National Enabling Technologies Strategy Public Awareness and Community Engagement (NETS-PACE), which ran from 2009 to 2013 (Marks and Russell 2015, p 99). The format for the forum had been previously

tested at RiAus in another NETS-PACE sponsored deliberative event examining issues associated with nanotechnology and water in July 2010. A report on the method and results of this forum was published following the event (Ankeny and Smith 2011). The project was funded to address the following questions:

- 1) What are the public's main concerns regarding synthetic biology?
- 2) What are their main aspirations or hopes for the technologies associated with synthetic biology?
- 3) How do they think these technologies should be regulated?
- 4) Do they view these technologies as raising distinct ethical or other issues in comparison to other biotechnologies?
- 5) How can a deliberative forum be used to engage the public on emerging scientific issues such as synthetic biology research? (ibid, p3)

This case study of deliberative public engagement with science was Australia's first public forum on synthetic biology, however deliberations had commenced internationally following announcement of the first synthetic genome.

The public announcement of the first cell with a synthetic genome (Gibson et al. 2010) represented an opportunity to put ideas of upstream public engagement to the test. European countries had begun considering policy implications of synthetic biology before the 2010 announcement. The Netherlands' national technology assessment institute released a report in 2006 that considered among other things governance, social, ethical and legal aspects (De Vriend 2006). In the UK the Royal Society began with a public call for views in 2007 then published a report calling for an inclusive 'art of governance' (Zhang et al. 2011). SYNBIOSAFE in 2008 was a collaborative European-driven digital discussion about safety and ethical aspects of synthetic biology

(Schmidt et al. 2008). Lentzos (2009) provided a snapshot of these various activities from a UK perspective.

In the US following the 2010 announcement, the President's Bioethics Commission deliberated how synthetic biology should be governed (Kaiser 2010), resulting in a report before the year's end. The report noted existing US initiatives such as the Synthetic Biology Project emerging from the Foresight and Governance Program of the Woodrow Wilson International Center for Scholars. Aspects of the US Synthetic Biology Project were the closest to the Australian forum described in explicitly focusing on engaging the public, rather than those with a professional interest in synthetic biology. However the US project focused more on public opinion polls than public deliberations seeking engagement (Hart Research Associates 2009).

Public deliberations should happen at an early enough stage to influence policy and development (Wilsdon and Willis 2004; Torgersen 2009). So 2011 seemed an ideal time to experiment with upstream engagement about synthetic biology in Australia, before domestic policy recommendations and applications of the technology emerged. Whereas for example in the US, public engagement followed recommendations of the Presidential Commission for the Study of Bioethical Issues, in Australia public deliberations in July 2011 had the potential to shape recommendations before they were made. The goal of the first Australian public deliberations was articulated as:

“to generate an agenda for future research into public attitudes toward synthetic biology and particularly policy about synthetic biology, as well as to articulate current public views regarding synthetic biology in the Australian context.” (Ankeny and Smith 2011, p4)

Method in the second case study

The event was hosted by the Royal Institution of Australia at The Science Exchange in Adelaide, with financial support from the Australian Government's National Enabling Technology Strategy and with ethical research approval through the University of Adelaide. The format for the forum had been previously tested with the same organisations in partnership in July 2010, in a deliberative event about nanotechnology and water. Now focused on audiovisual media production, during its early years the mandate of RiAus included fostering informed debate, promoting public awareness and understanding of science, and providing space for assuring a pluralistic, open and accountable process of policy analysis, research, decisionmaking and evaluation in the fields of science and technology and their impact on society. RiAus provided in kind support for the project, including staff time for convening the event, logistics, venue hire, technical capabilities, and marketing and promotion of the event.

As well as being financially supported by the Australian Government, the synthetic biology event actively involved science policymakers from the South Australian government, as observers and documenters. Invitations were issued to guest speakers and a facilitator, and the public forum was advertised (following ethics approval) in February-March 2011. Advertising occurred via the RiAus website, Twitter and other social networking media, email, and advertisements in local media, including some active and positive recruitment for people involved in policymaking as well as typically underrepresented groups at RiAus events, such as 18-35 year olds. This extra recruitment was done through social networks of volunteers. This method was mostly self-selection, which was considered appropriate for an initial pilot project, designed primarily to elicit the range of issues likely to be of concern and interest to a general

public. Dinner was offered as an incentive for participation and the presenter of a national radio program acted as MC. Participants completed a short demographic survey when applying for a ticket to attend through self-selection; a pool of tickets was kept aside to actively recruit participants from demographic gaps. All who initially applied to attend were accepted, with extra tickets then offered to people fitting demographic gaps. CLiKAPAD audience response systems were used to survey participants throughout the event and to vote on priorities.

The forum happened on Thursday 7 April 2011, starting at 6pm and running for nearly three hours. There were 77 public participants, as well as observing researchers and policymakers, catering staff, the MC and four presenters: two scientists, a lawyer and a bioethicist. Participants gave consent for their participation to be audio/videotaped and for their anonymised CLiKAPAD responses to be saved, as well as for all results to be analysed for research purposes.

Alan Saunders, who was an ABC Radio National presenter, facilitated the event, which began with short presentations by the four invited speakers. The first was Desmond Lun, who was an Associate Professor in the Department of Computer Science at Rutgers, The State University of New Jersey. The second was Claudia Vickers, who was a Research Fellow at the Australian Institute for Bioengineering and Nanotechnology, in the The University of Queensland. Alison McLennan, who was a PhD candidate in Law at Australian National University, considered legal aspects of this emerging field of science. Finally Rachel Ankeny, who was Associate Professor in History and Politics at the University of Adelaide, explored ethical issues. Video recordings of these talks remain publically available online.

After an opening round of using the e-voting technology to answer demographic and attitudinal questions, participants heard four expert talks averaging 13 minutes in length then asked questions about them. A second round of polling happened after the experts' presentations and resulting questions. Participants were then split into breakout groups of approximately eight people each and served dinner while given time for deliberations; the speakers were available to answer questions and participate in discussions. Participants were divided based on colours placed under their seats to encourage mixing, moving into different parts of the building where they were served dinner. Participants were asked specifically to discuss the main questions or issues they thought were important for policymakers to address about synthetic biology. After 40 minutes the groups returned to the main room, and a representative from each group was asked to share their main points. These were collated on screens displayed at the front of the room digitally, so that participants could vote on these main points using the audience response system. From the points collated from small-group discussions, participants voted on which they thought were most important, second most important and third most important for policymakers to consider. The process is presented in a running sheet below.

18:00 Participants arrive and have time to choose a seat, read the research project information sheet and interact with other participants.

18:10 The facilitator welcomes participants and guides them through the first round of using the e-voting system, for demographic and attitudinal questions.

18:15 The first expert presents, then participants ask questions.

18:35 The second expert presents, then participants ask questions.

18:55 The third expert presents, then participants ask questions.

19:15 The fourth expert presents, then participants ask questions.

19:35 Participants use the e-voting system for the second time, then break into small groups for deliberations during dinner.

20:15 Participants regroup and facilitator asks representatives from each group to share their policy priorities, which are transcribed on a screen for voting.

20:25 Voting on first policy priority

20:28 Voting on second policy priority

20:31 Voting on third policy priority

20:34 Final voting on attitudinal questions

20:40 Facilitator thanks participants and closes formal deliberations; some informal discussions continue.

Background to method in the third case study

In 2015 the Government of South Australia established a Royal Commission into the Nuclear Fuel Cycle. It was established to consider practical, economic and ethical issues raised by deeper potential involvement of South Australia in nuclear mining, enrichment, energy and storage (Scarce 2016). Australia is one of the largest uranium producers in the world (WHO 2001, p155), due to the uranium deposit and mine at Olympic Dam, in South Australia's north (Mudd 2010). Given South Australia's role in supplying nuclear fuel to the world, researchers have argued for a moral obligation to likewise play a role in storing resulting waste (Holland 2002, p287; Manning 2016).

The Royal Commission into the Nuclear Fuel Cycle cost 7.2 million Australian dollars and heard from 132 expert witnesses, including 41 international experts, over 37 sitting days (Weatherill 2016a). The report included 12 recommendations, particularly about the potential for nuclear fuel and waste storage. The report concluded it was both safe and viable for South Australia to pursue a fuel waste storage facility, which would have “extraordinary economic benefits” (ibid). It also highlighted the need for broad social and specific community consent to do so. So deliberative public engagement with science methods are being used to explore whether social and community consent for nuclear waste storage might exist.

Regardless of the state’s nuclear industry, the Government of South Australia had made a commitment to host two citizens’ juries before 2017, as part of a policy statement about reforming democracy, which also promised four deliberative democracy projects (Your SAY 2015). The Nuclear Citizens’ Jury was organised by the newDemocracy Foundation and democracyCo. The newDemocracy Foundation had previously organised the Australian Citizens’ Parliament, funded by the Australian Research Council, as well as other deliberations such as a participatory budgeting process in Sydney (Thompson 2012). The Australian Citizens’ Parliament happened in February 2009, with one participant from each federal electorate deliberating about how Australia's political system could be strengthened to serve citizens better, using a 21st Century Town Hall Meeting method (Dryzek 2009, p2). So the Nuclear Citizens’ Jury was organised by the experienced newDemocracy Foundation for the Government of South Australia as part of its policy of democratic reform. In contrast to the first two case studies, in which I was an investigator, I was not involved with organising the third

case study. As a citizen raised in South Australia studying methods of deliberative public engagement with science, it was a timely case study for this thesis.

Method in the third case study

The 52 participants in the third case study were selected via a random selection process performed “independently and at arm’s length from government” by the newDemocracy Foundation (Your SAY Nuclear 2016a). Recruitment was based on random sampling of 25,000 households from Australia Post’s database, which contains all physical addresses located in South Australia. There were 1,121 registrations of interest from households of interest. Census data profiling was used to select participants based on their age, gender, location and whether they lease or own a property, with the aim of ensuring that the jury of 52 people was “representative of the broader South Australian population” (Your SAY Nuclear 2016a).

These 52 participants met over two weekends in 2016, the 25th and 26th of June, followed by the 9th and 10th of July (Your SAY Nuclear 2016b). Deliberations over these four days were video recorded and transcribed. Transcripts indicated deliberations went for 7 hours (9:30-16:30) on Saturday 25th of June (Spark and Cannon 2016a); 5 hours (10:00-14:00) on Sunday 26th June (Spark and Cannon 2016b); 6 hours (10:30-16:30) on Saturday 9th of July (Spark and Cannon 2016c); and 7.5 hours (10-17:30) on Sunday 10 July (Spark and Cannon 2016d). Participants were provided with lunch and afternoon tea breaks. The final day of deliberations finished later than the others and concluded with the jurors presenting their recommendations to the South Australian Premier.

The jury based its deliberations on the Nuclear Fuel Cycle Royal Commission Report (Scarce 2016) and information presented in person by expert witnesses, who had also been witnesses for the Royal Commission. While the Sydney-based newDemocracy Foundation organised the overall process, the jury was facilitated by a South Australian consulting firm called democracyCo which was described as “at arm's length from government” (Your SAY Nuclear 2016b), though its proprietors have had careers in and consulting to the Government of South Australia (democracyCo 2016).

The outcome of the jury's deliberations was a report framed as a question: What are the parts of the Nuclear Fuel Cycle Royal Commission's Report that everyone needs to discuss?

The outcome report was framed as key topics to be discussed during the following statewide consultation program and a second citizen's jury. As well as the key topics, the report included a list of principles that were discussed in the introduction of this thesis. These principles were read out to the Premier during presentation of the report on the final afternoon of deliberations (Spark and Cannon 2016d, p336), followed by discussion of the key topics. An important aspect of this method was that it was designed to be iterative. A citizens' jury of 350 citizens, including the 52 who participated in the first Nuclear Citizens' Jury, was planned before the first started (Your SAY Nuclear 2016c). This future process was discussed by participants during their deliberations. Emphasis on iteration and future consideration of their principles indicated that embedding a second deliberative process with the design of the first was an important aspect of the method.

Discussion of methods

This thesis is based on analysing three case studies of deliberative public engagement with science through three tradeoffs in best practice. As a prerequisite for considering these tradeoffs in turn in later chapters, methods of the three case studies have been presented in this chapter. Case studies one and two were examples of deliberative voting methods, while the third case study was a citizen's jury, albeit one that engaged more participants than many juries.

Methods of recruitment for the three case studies varied. The first method used elements of snowball sampling, the second relied on self-selection, while the third used random sampling. This had implications for representativeness and inclusiveness that will be discussed in Chapter Four.

The method of the first case study involved participants deciding between three options, as a way of researching whether public participants could make research funding decisions. This deciding between three already defined research proposals was a more downstream method than the second and third case study. Both the second and third case study were designed to elicit public preference for policy priorities. The second case study resulted in a list of national policy priorities for synthetic biology. The third case study resulted in a list of priorities for further public engagement among South Australians about involvement in the nuclear fuel cycle.

The deliberative voting method in the second case study allowed individual but anonymised preferences to be recorded, whereas the citizens' jury method in the third case study was aimed at consensus among jurors. While the methods of the first and second case study allowed for collecting primary data in the form of votes, the second

and third case study included transcripts of deliberations. The method of the first case study did not preclude a transcript recording, rather resource limitations meant deliberations were unrecorded. Both deliberative voting and citizen's jury methods allow for the collection of primary data for analysis in the form of transcripts.

Methods of deliberative public engagement with science can be applied to issues with different boundaries and for both upstream and downstream engagement. For example, the deliberative voting method was used for a more downstream process around options for research funding in case study one. It was also used for a more upstream process of national policy priorities about synthetic biology in case study two. While case study three was also about policy priorities, it was focused on a state-level decision rather than a national one. However these different boundaries of governance can present problems and reveal some legitimacy and accountability problems in deliberative public engagement with science that will be discussed later in this thesis.

The third case study emerged from the need for social and community consent for a potential nuclear waste storage facility. Because this storage facility was proposed for South Australia, participation in deliberations have been limited to residents of the state. Iteration was embedded in this method, with a second citizen's jury planned from the outset, following town hall meetings throughout the state. However jurors' desires for more detailed information conflicted with national nuclear regulations, so legislative change would be needed to take forward these deliberations with information sought by the jurors. Thus the success of methods of deliberative public engagement with science is intertwined with national legislative regulatory methods, which are beyond the scope of this thesis. Likewise deliberations about synthetic biology policy became entangled with regulatory methods, both at national and international levels. Forthcoming chapters

of this thesis argue that the second and third case studies were examples of upstream engagement, in which uncertainty is high and multiple boundaries are relevant, both spatially and temporally. Thus evaluating these methods is difficult without evaluating the broader governance frameworks in which they exist, about which another thesis could be written.

Chapter Three: Results from case studies

Introduction

Results reported in this chapter are complemented by analysis in later chapters of open-ended survey responses and transcripts of deliberations. Results reported from the three case studies here include the demographic mix of participants, the outcomes of voting, the policy priorities agreed upon by participants, and their thoughts about the deliberative processes in which they participated. Broad themes in reasoning for decisionmaking are also discussed, drawing on open-ended responses to survey questions. Results of the three case studies differed depending on method, discussed in the previous chapter. In the first case study participants voted for one of three options. They also shared demographic and attitudinal data in surveys at the start of the forum and again at the end. The second case study was also a deliberative voting process, however it used e-voting technology rather than paper surveys. This meant that rather than individual responses for analysis and tracking changes between the beginning and end of the forum, results were already aggregated and anonymised. Participants were polled three times during the forum on attitudinal questions, but this data was aggregated by the e-voting system so analysis of individual responses throughout the forum was not possible. In contrast to the first two case studies in which I was directly involved as an investigator, the third case study was led by others and has been included for comparison. Data reported from the third case study was gathered from reports of the process rather than firsthand investigation.

Results from the first case study

There were 85 formal participants in total across the three events. The majority, 57, participated in Adelaide, whereas the two events in Canberra had 20 and 8 formal participants, respectively. Participants were considered formal if they registered prior to the event and participated in the voting and survey processes. There were several informal participants who did not complete surveys, mostly at the smaller venue in Canberra.

At the larger Adelaide event, participants were seated at round tables of eight, which facilitated discussion among those on the table about presentations and questions. At the more intimate Canberra venue, participants were spread on sofas and chairs around a room; conversation among them was limited to those nearby. In addition to the public participants, presenting scientists and facilitator, event volunteers, and hospitality staff participated informally.

Raw responses from before and after surveys were collected along with voting slips. There were 85 participants who participated in the surveys and voting processes across the three events. Response rates to the whole surveys were analysed to assess participants' engagement. Individual responses to open questions were analysed and processed to determine word frequency. Quantitative data were inputted to Microsoft Excel then analysed using SPSS.

With what aspects of the surveys and format did people engage most?

A few participants responded to open-ended and Likert-type questions but not rating questions. Likert questions were those in which people were asked to respond to a scale

from strongly agree to strongly disagree, whereas rating questions asked people to rate proposals on various criteria with a number.

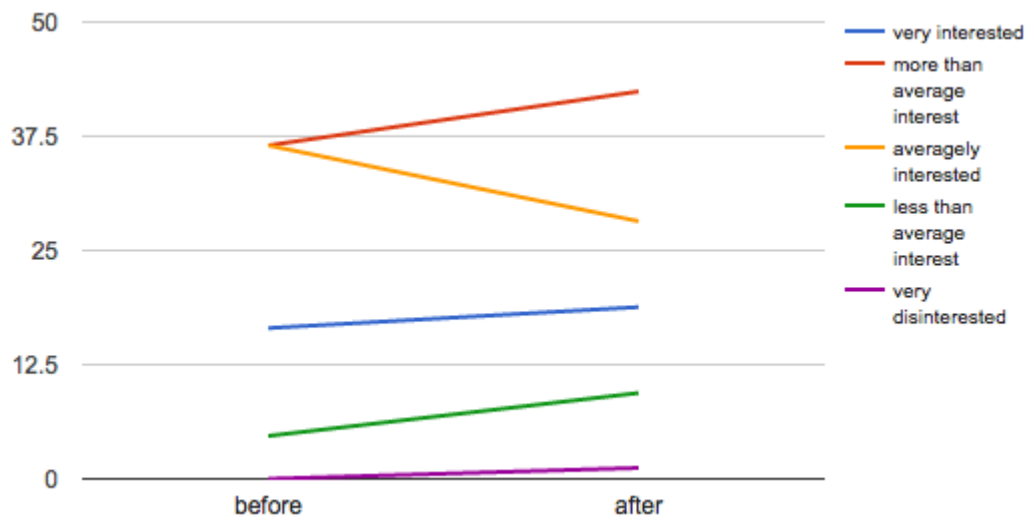
Of the 85 formal participants, 80 consistently responded to questions quantitatively rating the presentations, demonstrating the majority's interest and capacity to rate research proposals in the requested manner.

Participants were asked to vote for only one of the three presenters, reflected in the question wording: "which of the three projects did you vote for?" Although in theory participants could have written "all" or "none" or could have abstained from marking the vote paper, all 85 participants responded in the manner requested with a single, valid vote. This 100% response rate to the voting question suggests that participants valued the voting process.

Who participated?

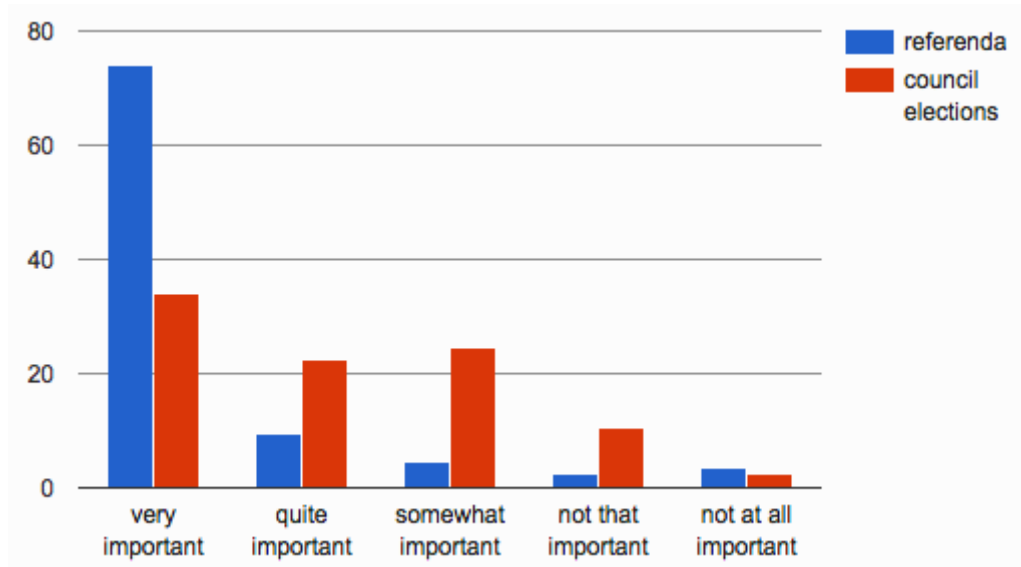
Participants were asked about their attitudes to science and politics in the pre-event survey. When asked about how they would rate their knowledge of science, 37% said they had average knowledge and the rest were split between rating themselves either above (30%) or below (28%) average. Only 5% reported below average interest in science. Their interest in science was surveyed following the event; Figure 2 shows interest before and after. There was an overall increase in interest with more reporting above-average interest after than before although participation confirm or strengthen the opinions of some who were not interested to begin with that an evening of deliberating about science did not interest them.

Figure 2: Percentage of participants' interest in science before and after



Political involvement in Australia was surveyed generally, with 34% of people considered themselves average, 35% considered themselves more, and 19% less than average. There were a minority (6%) who did not feel involved at all. Participants were also asked their thoughts on the importance of voting in national referenda and local councils, with results shown in Figure 3. Voting in a referendum is a method of direct democracy for making policy about a particular issue, whereas voting in local council elections is a method of representation in policymaking on a range of issues at local levels. Significantly more participants thought voting in a referendum was very important (74%), contrasted with a third thinking voting in local elections was important (34%). Despite differences in valuing different democratic methods, most participants felt both were somewhat important or more so, demonstrating engagement with political processes.

Figure 3: Participants' responses to importance of voting in referenda or local councils, as a percentage



Participants were asked in the pre-event survey to list three areas of their own expertise, in an open-ended response. This was done instead of asking directly about profession for two reasons. First, people with science qualifications can move into other professions. People without qualifications in science may also develop expertise through their experiences, as patients, for example. Second, asking participants to consider their own areas of expertise ahead of interacting with scientists was designed to promote feelings of competence and the concept of lay expertise.

A higher than average level of education (Australian Bureau of Statistics 2010a) was inferred from the number of responses in areas including law, policy, education, and information technology. Such professional areas of expertise were more commonly listed first, with topics such as travel or sport listed second or third.

This inference about above-average education levels was supported by quantitative questions. People were asked to tick their educational experiences, more than one if applicable. A third (33%) had postgraduate experience, while only one person reported

not completing high school. Some participants chose not to answer the education question. Of 85 participants across three events, 48 were women and 32 were men; 5 people did not specify their gender. People born between 1975 and 1984 were overrepresented compared with Australia's general population (Australian Bureau of Statistics 2010b), comprising more than 40% of the participants, while 18% were born between 1949 and 1957. Adults born in the 1960s or before 1940 were the least represented.

In Canberra, events did not reach capacity, so some people with science degrees were invited from the waiting list to participate. The Adelaide event reached capacity with people who had not indicated they had science degrees. Calling for participants without science qualifications seemed effective, with some exceptions. Assumed exceptions included people who listed an area of expertise as epidemiology or microbiology.

When did people participate?

Events at different times of the day in different places recruited different participants. The majority, 57, participated in Adelaide, whereas the two events in Canberra had 20 and 8 formal participants, respectively. Participants were considered formal if they registered prior to the event and participated in the voting and survey processes (ibid, p3). The smallest event was held in Canberra over lunchtime; this event had the highest number of drop-ins. At least 6 people were noted coming and going during this event, typically sitting to watch parts of the presentations, without participating in the surveys, voting, or asking questions. Evening events were better attended than lunchtime events, as 77 people participated in the evening as opposed to 8 during the day—that is 90.5% participating in the evening. However, people were more likely to stop by during the

day, so less formal events that do not require committed participation may suit lunchtimes better.

Which research proposal was preferred?

Voting slips counted at the end of the events were compared with reported votes on the second surveys later. Votes on the slips and surveys were consistent. Across all three events, regardless of presentation order, one project consistently received the most votes. At each of the three events and overall, the research proposal about increasing salinity tolerance received the most votes (52 in total). The nitrogen use efficiency proposal received one more vote (17) than the beta-glucan proposal (16).

How did participants rate the research proposals?

Similar to the UK study, participants were asked to rate each of the three presentations on 11 criteria. Rating was on a scale between 1 and 5, in which 1 represented excellent and 5 poor. The criteria are listed in Table 3.1.

Table 3.1: Criteria on which participants rated the proposals

-
1. My understanding;
 2. Benefit to society;
 3. Benefit to environment;
 4. Personal relevance;
 5. Speaker persuasiveness;
 6. Research innovation;
 7. Likeability of researcher;
 8. Interesting talk;
 9. Speaker trustworthiness;
 10. Timely outcomes; and
 11. Potential for profit.
-

These criteria reflect those used in the UK study (Rowe et al. 2010), covering benefits to society or environment; likeability, trustworthiness or persuasiveness of the researcher; whether participants found the talk understandable, interesting, or personally relevant; and whether the research would have timely outcomes, be innovative, or profitable.

Participants' ratings of the research proposals on the 11 criteria listed in Table 3.1 were aggregated. Averages (means) of the ratings for each research proposal were calculated. These were sorted into a list with the highest rating for a research proposal on a given criteria at the top, shown in Table 3.2.

Table 3.2 shows the most popular proposal about salinity was rated equally best for "my understanding" and "benefit to society". The nitrogen proposal rated the best on "benefit to environment", which ranked third highest overall, followed by "interesting talk" for the salinity project. The nitrogen proposal rated the best on "speaker trustworthiness" and "speaker persuasiveness", despite this proposal not receiving as many votes as the salinity project.

Table 3.2: Average criteria ratings, from highest to lowest

Criteria for each research project	Score (1 = <i>excellent</i> , 5 = <i>poor</i>)
My understanding: Salinity project	1.71
Benefit to society: Salinity project	1.71
Benefit to environment: Nitrogen project	1.85
Interesting talk: Salinity project	1.89
My understanding: Nitrogen project	1.98
Benefit to society: Nitrogen project	2.01
Benefit to environment: Salinity project	2.03
Interesting talk: Nitrogen project	2.03
Likeability of researcher: Salinity project	2.04
Speaker trustworthiness: Nitrogen project	2.05
Potential for profit: Salinity project	2.06
Likeability of researcher: Nitrogen project	2.06
Speaker trustworthiness: Salinity project	2.08
Benefit to society: Beta-glucan project	2.1
Speaker persuasiveness: Nitrogen project	2.13
Speaker trustworthiness: Beta-glucan project	2.21
Potential for profit: Nitrogen project	2.23
Benefit to environment: Beta-glucan project	2.23
Speaker persuasiveness: Salinity project	2.24
Likeability of researcher: Beta-glucan project	2.25
Research innovation: Salinity project	2.31
Potential for profit: Beta-glucan project	2.34
Research innovation: Nitrogen project	2.36
Timely outcomes: Salinity project	2.4
Research innovation: Beta-glucan project	2.41
My understanding: Beta-glucan project	2.46
Interesting talk: Beta-glucan project	2.48
Personal relevance: Salinity project	2.55
Timely outcomes: Nitrogen project	2.58
Personal relevance: Nitrogen project	2.69
Timely outcomes: Beta-glucan project	2.7
Speaker persuasiveness: Beta-glucan project	2.74
Personal relevance: Beta-glucan project	2.8

Why did people vote the way that they did?

As well as inferring people's' voting rationales from rankings described above, participants were explicitly asked why they voted the way that they did in an open-ended question, yielding qualitative responses. These responses were coded and codes

were then grouped into several themes. Of the 85 formal participants, 6 did not give a response to the open-ended question, so there were 79 qualitative responses for analysis. For each answer more than one code was identified, depending on the complexity of the response. For example, the shortest response “For the greater good!” was coded simply as “benefit”, while the relatively long responses such as the example below were coded several ways:

“The other proposals did not attempt to alleviate environmental problems in a holistic way. I found C arrogant while A considered and polite when defending her research. A's research had multiple opportunities - food and environment aspects were positive especially in a political setting where biofuels are seen as a solution. This research would allow a better solution from that being currently pursued. C did not address the problem of salinity - rather only a coping strategy.”

This 75 word response contained several themes so was coded nine ways. One code was “problem/solution”; a way several respondents framed their reasoning. Another was “holistic”, a frame considered by a minority of participants. Another code was “presenter”, so how many participants who referred to the presenter in their decisionmaking could be analysed. Others codes were “environment” and “political”, as well as “salinity”, “food” and “biofuels”. Finally “coping” was a code, allowing analysis of frames between reasoning that talked about resilience and coping versus thriving and growth. This example is highlighted as an example of relatively complex reasoning, contrasted with the shortest reasoning above. Most were less complex in themes. However another outlier among responses was the below, containing only 18 words but several themes that were coded differently to the above example:

“More advanced research (comparatively). Solid methodology. Existing recognition and partnership. Benefit to Australian export industry. Social/health benefits.”

Though being only 18 words it contained several themes, so was also coded nine ways with “short-term”, “method”, “recognition”, “collaboration”, “industry”, “social”, “health”, “benefit” and “Australia”.

Outcomes were deliberately coded with “benefit” and/or “problem/solution”, given these different words might have revealed different frames for decisionmaking. This is indicated in the two responses above. The first person reported their decisionmaking considered holistic solutions to environmental problems. The second person reported their decisionmaking considered research methods and outcomes for Australian exports, followed by social and health benefits. Both decisions emerged from the same deliberative process and the same proposals by scientists; both responses indicate good understanding of the presentations. This demonstrates the validity of different frames for decisionmaking, which will be discussed further in this thesis, particularly in Chapter Five about public versus organisational frames.

A contrast between the two responses presented above is how the first person explicitly referred to their impressions of the presenter in their response, while the second person wrote from an objective third person perspective and did not make reference to the presenter. Only 7 of the 75 responses explicitly mentioned the presenter in explaining why they voted the way they did. In contrast, 23 explicitly mentioned salinity, the most common theme. These results reflect the rankings discussed above, which indicated people were more influenced by the topic of the proposal than by the presenter. Other predominant themes were short-term benefits and whether an issue was the most urgent or pressing. This will be discussed further in later chapters about upstream and actionable outcomes, then local and transboundary issue framing.

As well as coding the qualitative responses, the text of the 79 raw responses were analysed using two different phrase frequency counters to determine the most common phrases in the qualitative responses. Table 3.3 shows the list of words used concurrently more than two times in the dataset.

Table 3.3: Words used concurrently more than twice

salinity is	11
of the	10
is a	9
the most	8
i think	6
to be	5
most important	4
in the	4
this research	4
to australia	4
rather than	4
a very	4
because i	4
the potential	3
australia and	3
the proposal	3
for the	3
short term	3
to the	3
benefit for	3
to me	3
health benefits	3
to climate	3
in a	3
is the	3
research is	3
it was	3
i thought	3
a huge	3
i feel	3

This reflects the conclusion that participants justified their decisionmaking based on the proposals presented rather than who presented them, given that salinity, research and proposal were appeared in top phrases, whereas presenter, scientist or researcher were not. Emerging from this dataset was the importance of location, with “Australia” appearing twice in this list, despite the location of benefits not being a criteria on which

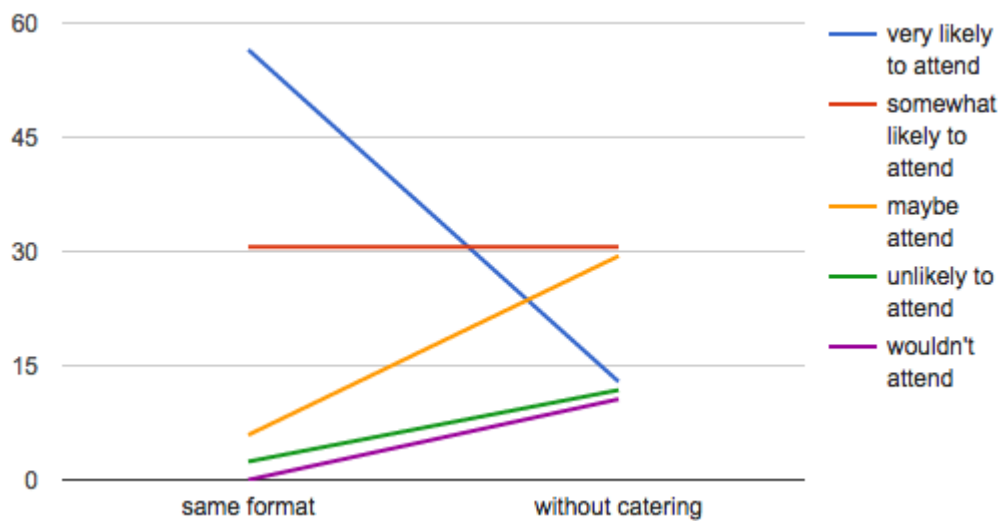
participants were asked to rate the proposals. Another finding from this phrase analysis is that twice as many people used “I think” in their reasoning than “I feel”. This is related to theory and research in deliberative democracy about what types of communicative action are appropriate. Rational argumentation is core to deliberative democracy, whereas the role of emotion in deliberative communication is controversial. Research about the role of different communicative actions in deliberative democracy will be discussed later in this chapter and thesis.

What did participants think of the event?

Participants were asked to rate the event they attended with three Likert-type questions and one open-ended question. They were asked about enjoyment and likelihood of attending again. They were also asked their likelihood of attending again without food and drink as incentives. The open-ended question requested suggestions for improvement. Feedback was positive; 87% of the participants rated their enjoyment as above average and no-one reported below average. The same percentage said they were likely to attend a similar event again, although two people were unlikely to attend again.

However, when asked whether they would attend without the meal incentive, less than half of the participants (46%) said they would be likely to attend; 12% would be unlikely to; 11% would not. The blue line in Figure 4 shows the fall in likely attendance without catering. This demonstrates the importance of incentives for participation.

Figure 4: Percentage of participants likely to attend again, based on the same format or without meal catering



Participants' thoughts on making research funding decisions

Participants were asked how useful they thought such a process would be for making real funding decisions. Of the 85 participants, 77 responded to the open-ended question asking them to explain why they thought the events would or would not be useful for making real funding decisions. All responded to the preceding quantitative scale question. More than half thought it would be useful (54%), although 29% were unsure, 12% thought it would not be of much use and 5% thought it would be useless. Of those who did not think it would be useful, concerns were that the event was too brief and information too shallow for people to make an informed decision.

“Some explanations were not thorough enough. Not enough time for clarification. Perhaps to be used in conjunction with expert opinion however definitely not alone. Very skeptical about lay people making decisions without proper knowledge, background and info on implications.”

This idea of lack of proper knowledge will be critiqued in this thesis, particularly in Chapter Seven. In contrast, another participant thought that perspectives could contribute useful information that scientists lacked:

“Public perspective. Also sometimes public may come up with ideas that scientists may not have considered... back to basics...”

The value of stimulating thinking was discussed even when respondents thought their ability to understand some of what was presented was inadequate.

“I think they would be useful in some ways because it gives the general public an idea of what is going on in the research field and gets them thinking about what's important and what implications society's actions have. On the other hand, it is a little difficult to make an informed decision because some concepts 'go over your head' due to lack of understanding of terminology/ideas/concepts and science-based knowledge.”

Inadequate time for deliberations was a strong theme in response to this question, regardless of whether people did or did not think such a method was useful. For example, this positive response nonetheless was concerned about the amount of time and information:

“I needed to ask more clarifying questions to come to a decision. This event is a great idea - but need more information to make an informed decision ie. more clarifying questions and time for reflection.”

Some thought that the presenter or presentation style influenced decisions.

“A lot depends on the presentation skills of the scientists rather than on an impartial evaluation of the research proposals. Does help indicate what the public might value most though.”

Some discussed the value of scientists making their case to the public.

“Good public presentation. Scientists put on their toes regarding public opinion questions. Have to think practicalities go beyond genetics - back to real world.”

Feedback from those who thought it would be useful reported what they learnt from the process and that information was valuable. They also discussed the importance of democracy and giving everyday people voices in decisionmaking, as well as how the process promoted a sense of community. For example:

“It enables communities to be able to be given both information and choice as to what issues they think are more important for their money to be spent on and what issues they believe are worthy to be pursued.”

Collaborative learning is a feature of deliberative democracy which will be discussed in later chapters of this thesis. One participant responded to the question about whether such a method would be useful in a way that epitomised the benefits of collaborative learning: “Sharing the insight, sharing the sense of community involvement.”

The theme of “public” was discussed by more than a third of participants. There are multiple meanings of public, which will be discussed further in the subsequent chapters. Some participants discussed public as a group of people, while some discussed public as a type of knowledge. One participant referred to public twice, once to describe a group of people and once to describe a quality of the presentation:

“I think they would be useful because (ideally) the public should have a say in how funding is spent, and all of the scientists this evening presented their research in a very accessible and public-friendly manner.”

Other participants discussed similar themes but without mentioning public, for example:

“general population gets to decide how fund are used. Relevancy to real life!” One participant thought that members of the public were less likely to have bias, but also

discussed in the same context lobby groups and special interests taking over, suggesting a meaning of the public that excluded special interest groups.

“Good to understand perspective of members of public who are less likely to have bias towards particular projects compared to industry, other scientists, lobby groups. Might be a problem with not getting diverse enough group turning up or getting too many people with special interests taking over. Good way of testing whether benefits of research are easily understood by public, might also be useful to know reasons for choosing project.”

The idea that particular interests take over other forms was echoed by another participant.

“Would ease citizens' concerns about scientific research, taking it out of forums where vested interests have undue influence.”

This idea that having a stake in decisionmaking influences outcomes was discussed by another participant who framed it as personal versus community interest.

“People will tend to vote according to their self-interest (personal gain) rather than the community (global gain).”

This idea that personal interest equates with personal gain while community equates with global gain will be revisited in Chapter Seven, about transboundary and local issues. In contrast to the third of participants who discussed the public and their lack of awareness, one respondent discussed the group's representativeness of those making funding decisions:

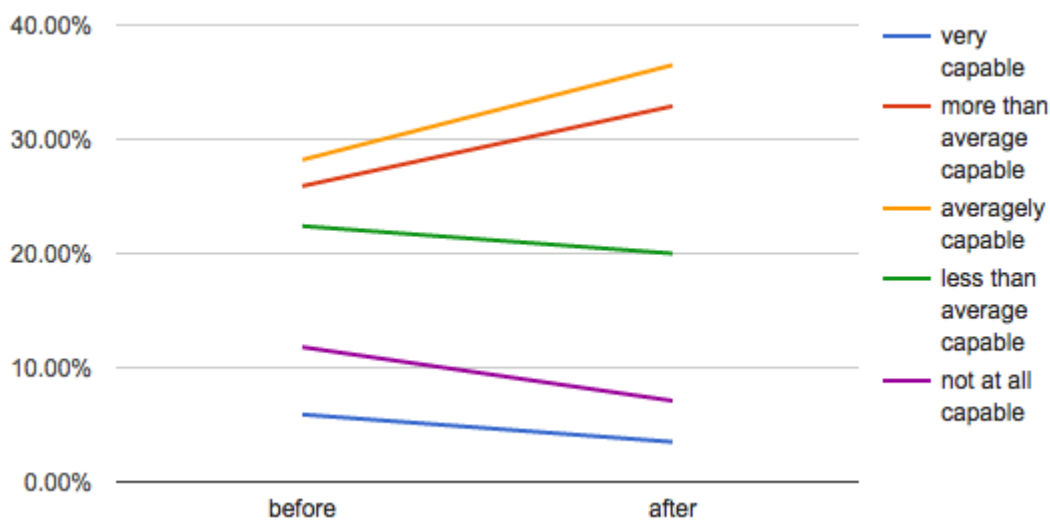
“Takes into account a wide demographic comprised of many individuals, this group of individuals is probably representative at least to some extent of those that would make the real funding decisions.”

This demonstrates there were diverse perceptions among participants about who was in the deliberating group and whether they had adequate understanding for decisionmaking.

Participants' perceptions of their own ability to make funding decisions

Participants were surveyed before and after about their perceptions of their own capacity to decide what science should be funded. Figure 5 shows how participants' perceptions of their ability to decide what science should actually be funded before and after deliberations.

Figure 5: Percentage responses from first and second survey question: how would you rate your ability to decide what science should actually be funded?



There were falls in the most extreme ratings after participants had deliberated with others: both feelings of being not at all capable or very capable reduced. More participants felt averagely capable or more capable than average following

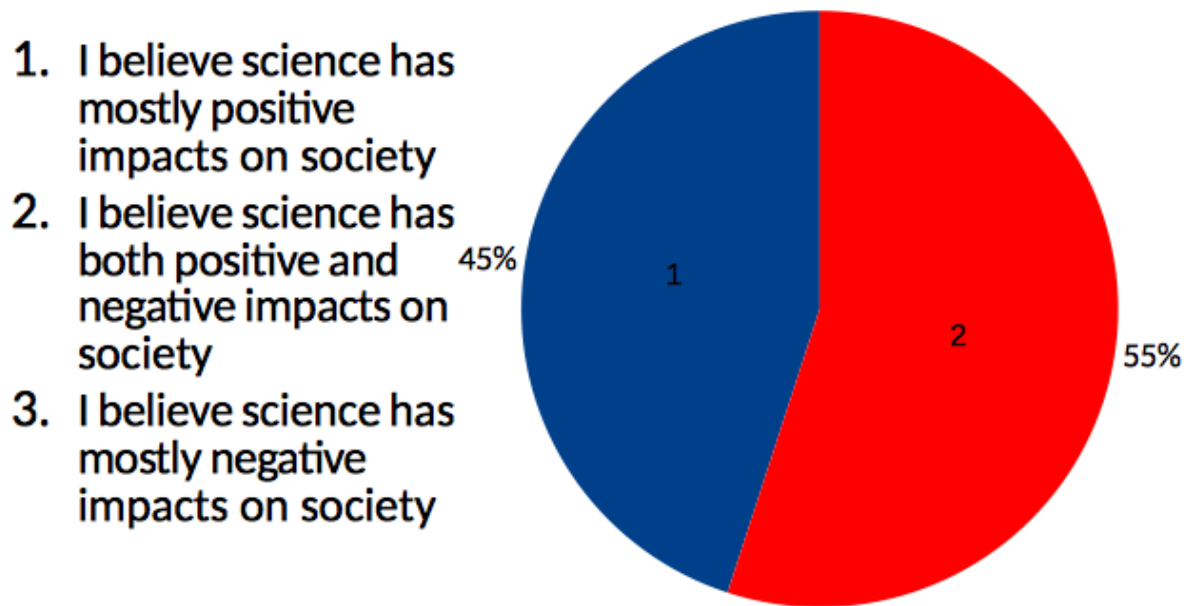
deliberations. While there was no majority response, the most common response was average capability before and after deliberations.

Overall most participants in the first case study were engaged with the process, enjoyed it and would participate again, though for some repeat participation depended on the meal incentive. Participants reached a consistent majority decision across three iterations of deliberations, indicating that such a method could potentially be used for making consistent research funding decisions. However the brevity of this process was of concern to many in terms of its effectiveness for making real funding decisions.

Results from the second case study

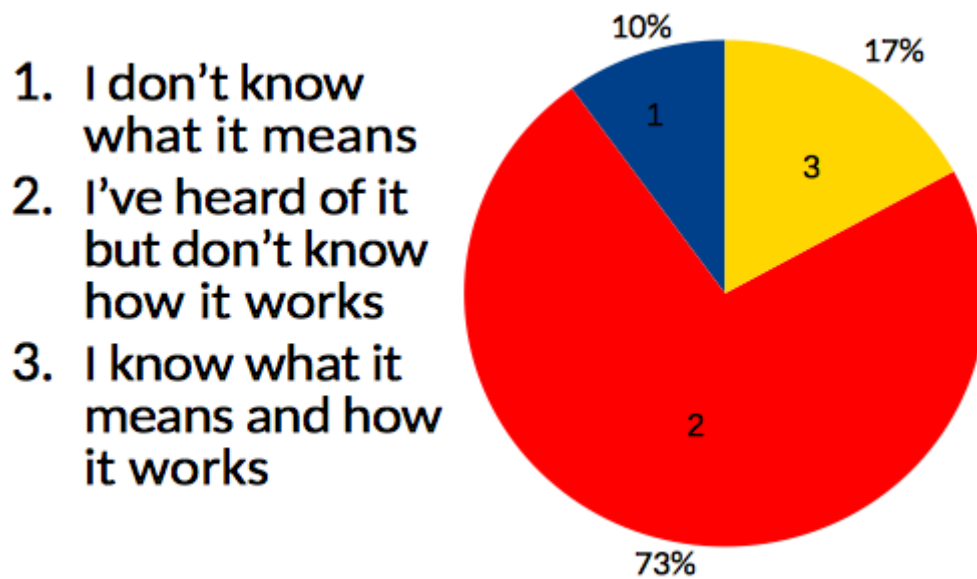
There were 77 participants in the second case study. These participants used e-voting technology to respond to questions, which meant responses were anonymised and responses to the same question at different points during the forum could not be traced to individual respondents. No participants thought that science had mostly negative impacts on society, shown in Figure 6. Nearly half (45%) voted for the belief that science had mostly positive impacts on society, while more than half (55%) thought it had both positive and negative benefits.

Figure 6: E-voting results for question: Which of these statements best sums up your attitude towards developments in science and technology?



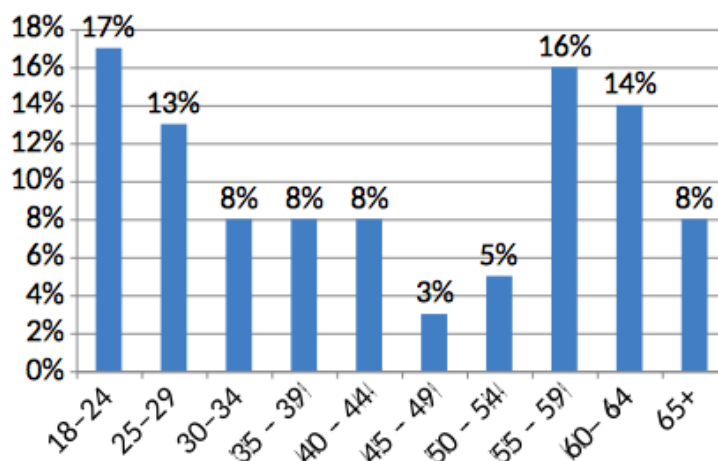
There was little understanding of what synthetic biology was at the beginning of the forum, shown in Figure 7. The least number of participants did not know what synthetic biology means at all (10%), while the majority had heard of it but did not know how it worked (73%). More than 10 people (17%) thought they knew what it means and how it works, indicating participants with expertise, in contrast with the first case study.

Figure 7: E-voting results for question: Consider the term ‘synthetic biology’: how would you rate your understanding of it?



There were a range of ages, shown in Figure 8. There were more female (56%) than male (44%) participants.

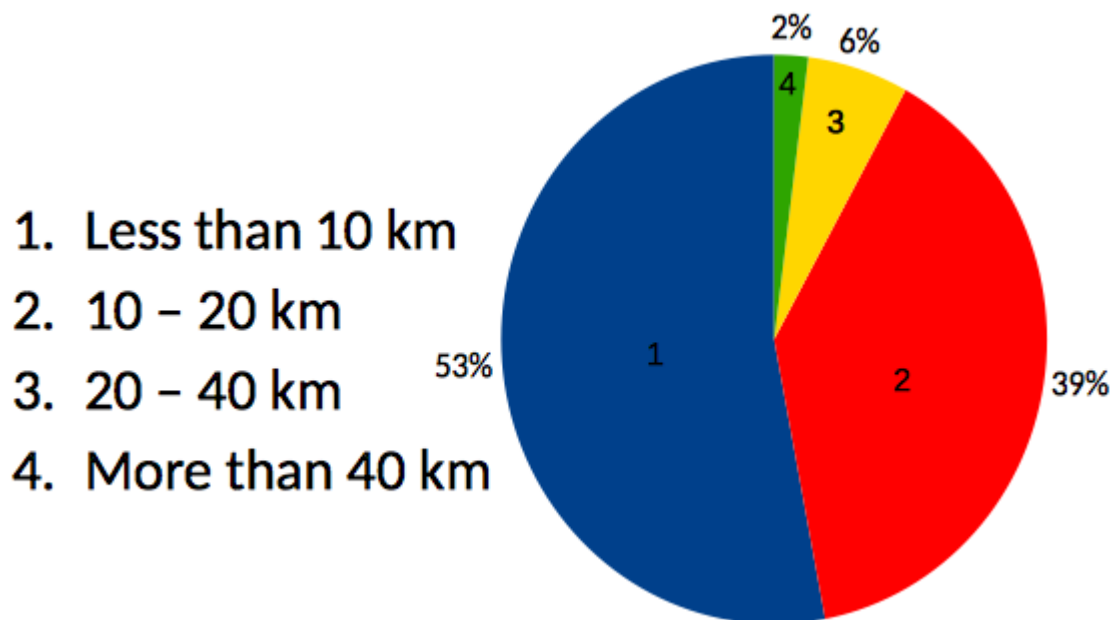
Figure 8: E-voting results for ages of participants



Slight more than half (53%) people travelled less than 10km to the event, as Figure 9 shows, indicating the majority lived around Adelaide. Only 8% of travelled more than

20km to participate, with more than a third (39%) travelling from suburban or peri-urban areas.

Figure 9: E-voting results for distance travelled to participate



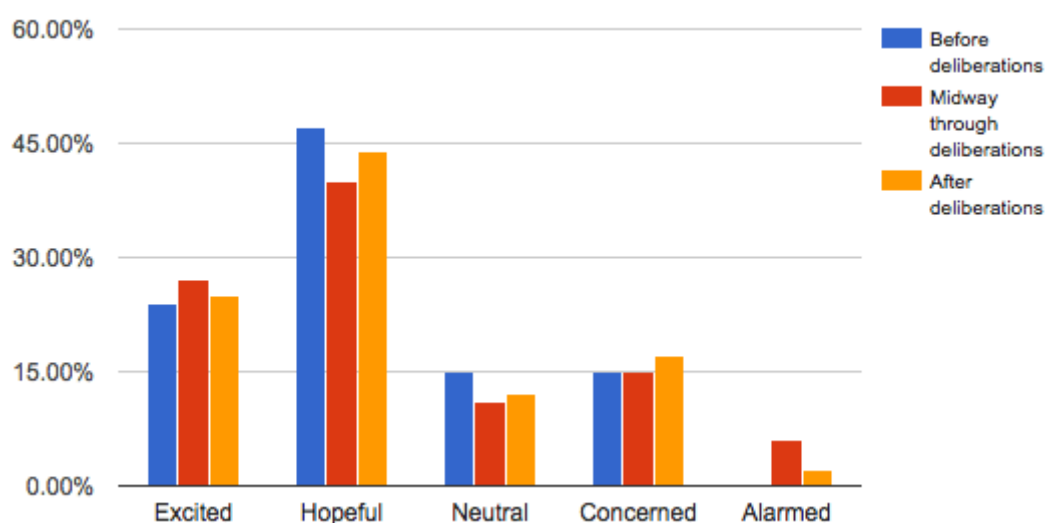
Participants gave consent for their participation to be audio/videotaped and for their anonymised clikapad responses to be saved, as well for all results to be analysed for research purposes. Audio recording resulted in the transcript shown in the Appendix of this thesis, video recording was used for the expert's presentations only, not participants' questions or deliberations.

What were participants' general attitudes toward synthetic biology?

At three time points during the forum participants' general attitudes toward the potential implications of synthetic biology were polled. Participants' views differed, though the majority reported either they were 'excited' or 'hopeful' about synthetic biology's implications. In the second round of polling following the presentations and discussion,

more people reported being either ‘concerned’ or for the first time ‘alarmed,’ but by the end of the forum, this number was reduced. These changing results over time are shown in Figure 10.

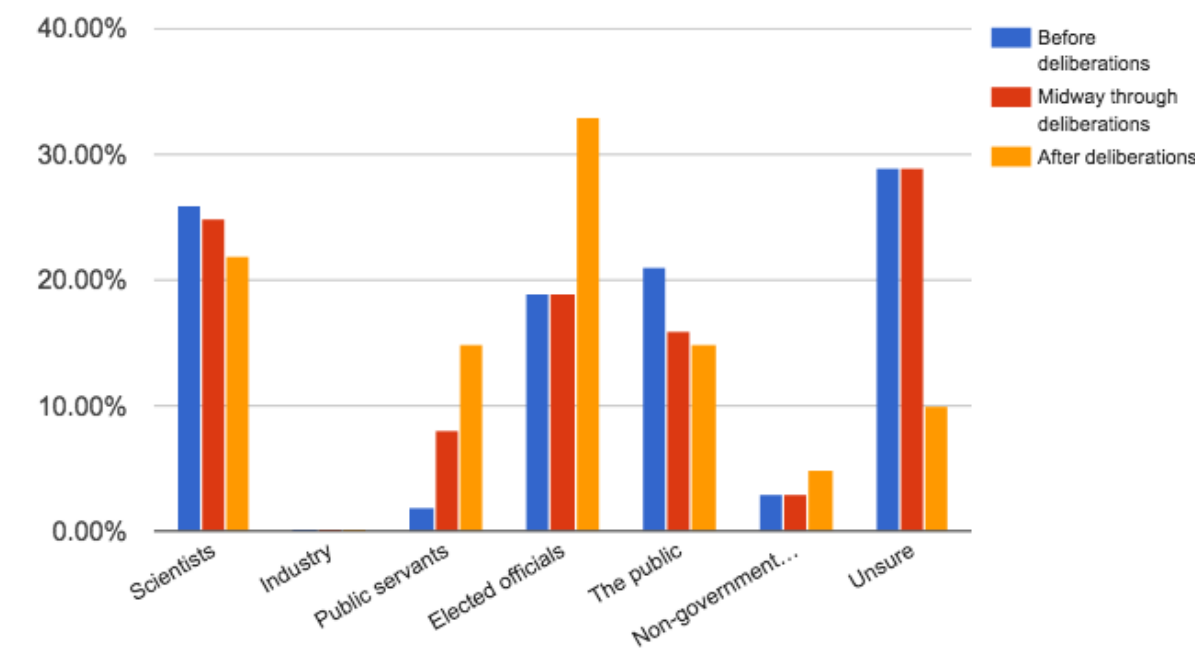
Figure 10: E-voting at three timepoints in response to: Which best describes your general attitude toward the potential implications of synthetic biology?



Who should be decisionmakers about synthetic biology?

Participants were asked at the start of the forum, following presentations, then again following group discussions about who should be the primary decisionmakers about permitting use of synthetic biology. This question was also asked in the first case study, and in the UK study on which the first case study was based. Throughout the polls, industry received no votes, and non-governmental organisations including charities received few. Figure 11 shows results from e-voting in the second case study.

Figure 11: E-voting at three timepoints in response to: who should be the primary decisionmakers about permitting use of synthetic biology?



Belief that elected officials should decide jumped in the final poll, reaching a third after being stable at 19% in the two earlier polls. In the first two polling points, nearly one-third (29%) of participants reported that they were unsure. This uncertainty reduced to 10% following deliberations. Support for the public as decisionmakers declined slightly following the presentations, never reaching more than 21% at the beginning of the forum. In the last poll at the end of the forum, elected officials was the most popular response, followed by scientists. These results indicating no majority votes for any decisionmakers were reflected in later results showing the highest priority for policy being the question of who should decide. The presence of this question about who should be the decisionmakers during polls likely primed participants to discuss this in their deliberations and thus rate it highly in their priorities.

What did participants think about applications of synthetic biology?

Following the presentations and again after the small-group discussions, participants were asked about their support for different possible applications of synthetic biology. The three applications subject to voting were the production of biofuels; soil remediation; and production of medicines.

Levels of support were high for all three applications both times, with the majority indicating strong support or support. However support went down slightly for all uses following deliberations, shown in Figure 12. Figure 13 shows that neutrality towards using synthetic biology to produce medicines stayed consistent, whereas less were neutral about soil remediation after deliberations. Opposition for all uses remained below 15% throughout; opposition to using synthetic biology to remediate soil went up slightly following deliberations, as shown in Figure 14. This indicates that deliberations impacted participants' perceptions of using synthetic biology to remediate soil more than for producing medicines, which as will be argued later in this thesis relates to location of risks and benefits, given that soil remediation is typically a more geographically situated issue than medicine production.

Figure 12: Percentage of participants supporting three applications of synthetic biology, after presentations then after deliberations

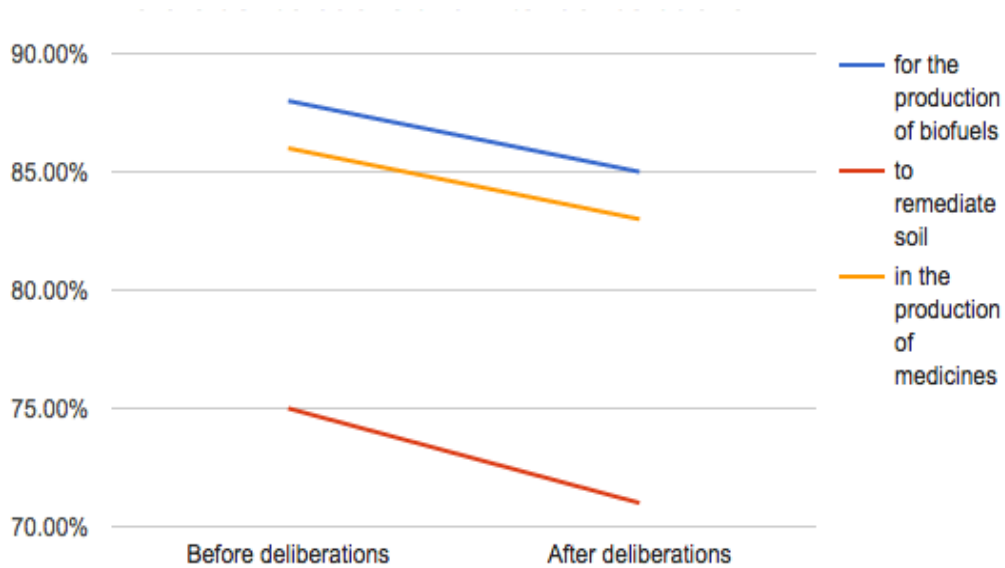


Figure 13: Percentage of participants neutral about three applications of synthetic biology, after presentations then after deliberations

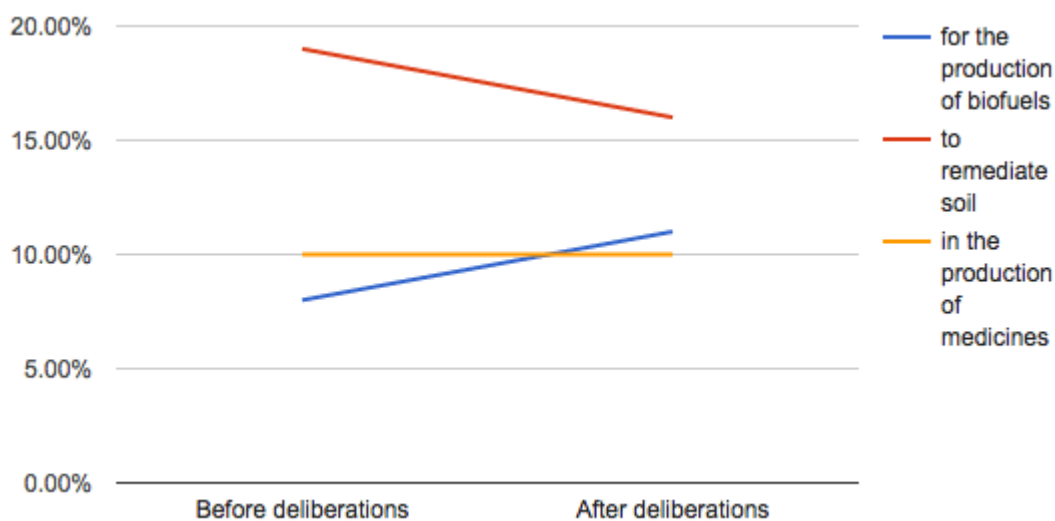
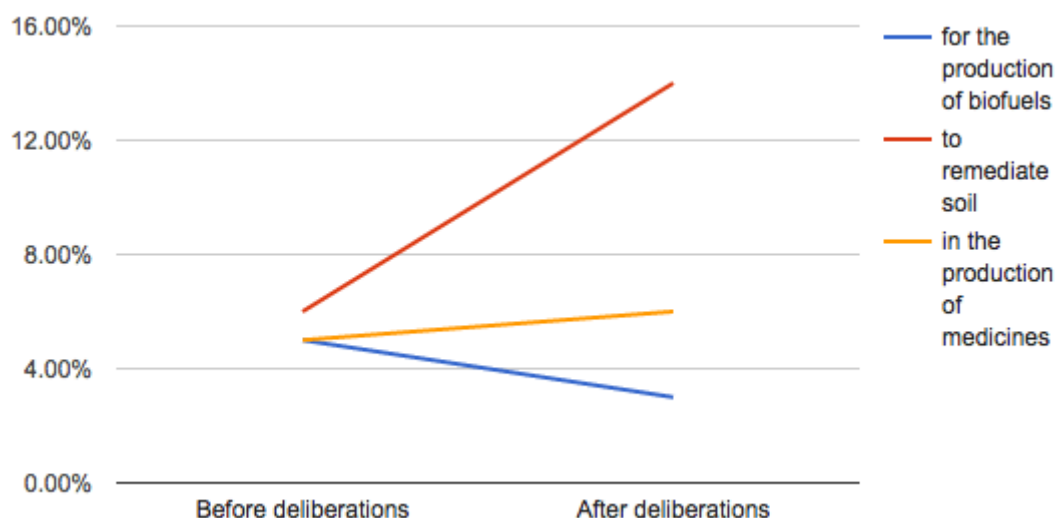


Figure 14: Percentage of participants opposing applications of synthetic biology, after presentations then after deliberations



What did participants consider the most important policy issues?

The most important set of findings relates to the policy issues identified in the small-group discussions and discussed at length in the closing, large-group discussion. The policy issues identified are listed in Table 3.4 in order of importance according to participants. This table shows results from three separate voting rounds one during the forum, asking the 77 participants to vote on their first, second and third highest priority for synthetic biology policy to address from the list of nine topics.

Table 3.4 shows that the highest ranked concern across the three voting rounds was about who should be the primary decisionmakers. However, more people rated safety, control and ethical frameworks as their highest concern, as well as transparency and monitoring technologies. The question of decisionmakers was most commonly considered second or third priority, leading to its highest ranking as priority overall.

Table 3.4: Highest priority policy issues

Ranking	Issue	Highest priority (%)	Second priority (%)	Third priority (%)	Sum
1	Who should be the primary decisionmakers	13	35	20	68.00
2	Safety, control and ethical frameworks	25	18	16	59.00
3	Transparency and monitoring of technologies	21	14	15	50.00
4	Need for education and public understanding of synthetic biology	15	10	13	38.00
5	Risk/benefit analyses	9	10	7	26.00
6	Practicality of regulations recognising potentials, certainties, and boundaries	4	4	15	23.00
7	Need for a systemic/holistic view	6	2	7	15.00
8	Concerns about benefits from commercialisation and IP laws	4	6	4	14.00
9	Funding mechanisms (public versus private returns)	4	2	4	10.00

Funding mechanisms and intellectual property concerns were voted the least important issues of the nine highlighted as important through the discussions. The need for education and public understanding received 15% of the votes for highest priority, while the practicality of regulations received 15% of votes for third priority. Only the question of who should be decisionmakers was voted as a priority by two-thirds of participants. Safety and control was a priority of more than half, with transparency and monitoring a priority of exactly 50%.

The limitations of the e-voting software used are revealed in the presentation of this data. The table above is data yielded by the software, so more precise data, such as the frequency of votes in each round, is not available. It is not known whether all 77 participants voted in each round, or whether some people chose not to vote. Also there was no linking of responses to particular e-voting devices, so there is no way to track whether the same people voted for the same option three times in a row.

Transcript of deliberations in the second case study

Walmsley (2010, p454) discussed the “black box” of deliberation in the middle of deliberative public engagement with science projects. In contrast to the first case study, where discussions leading up to voting and survey results were unrecorded, parts of deliberations in the second study were recorded for analysis.

Two parts of the deliberations were recorded. The first recorded part was the question and answer session after the expert presentations. Participants used the e-voting technology to record their responses to questions at the start of the night. Expert presentations happened, this question and answer session happened, then e-voting happened again. Following this, the large groups divided into small groups for unrecorded discussions. The group came together again as a large group to share their small-group priorities - this large-group discussion was also recorded. Following sharing in the large group, participants voted on priorities that had been summarised and typed in for presentation in real time on a projected screen, allowing everyone to vote in prioritising the issues discussed. Three voting rounds on the priorities happened, in which people voted on their first, second and third priority. Following this, people voted again on the survey questions iterated at the start of the evening and following the

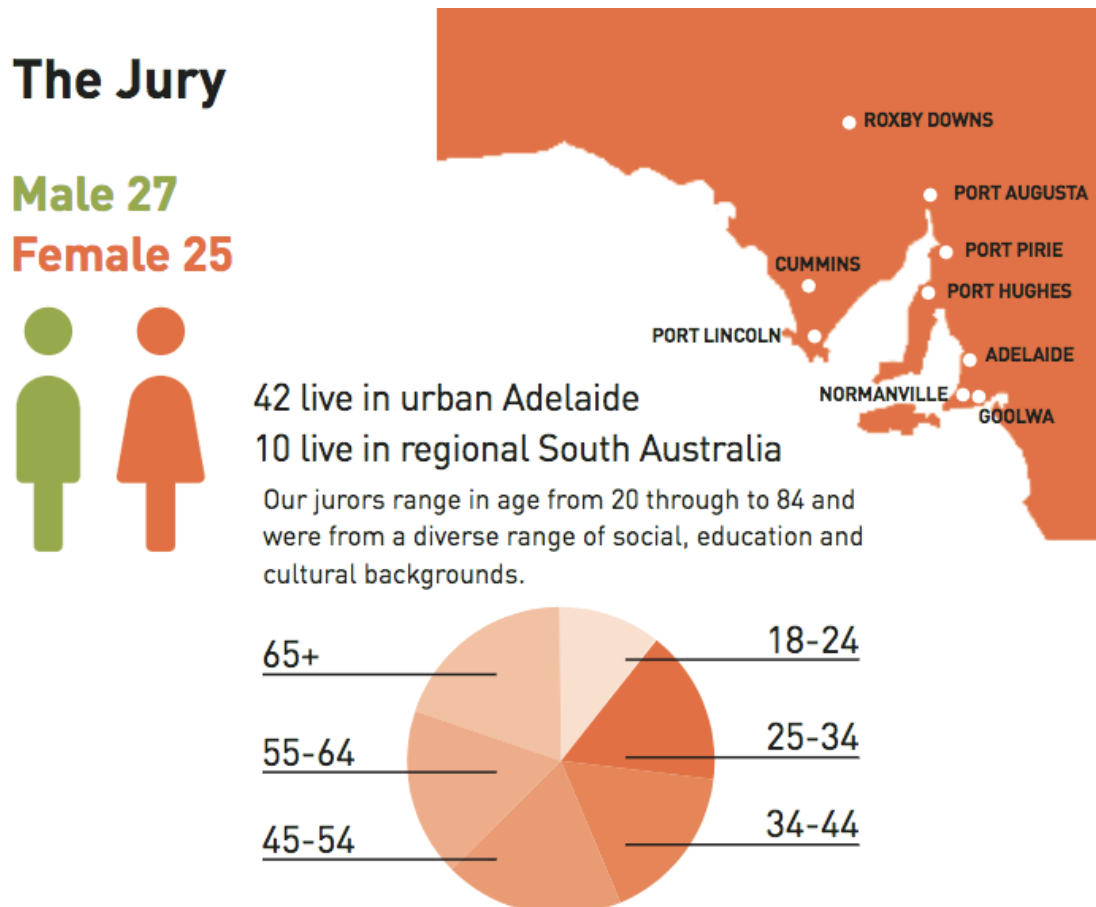
question and answer session. The final part of the forum following the voting was not recorded in the transcript.

The Appendix of this thesis is the transcript from deliberations in case study two, which has been an invaluable source of data for analyses in this thesis and is quoted in later chapters. The transcript was analysed with each speaker's contribution coded under one or two themes. Experimental analysis of the transcript was done using the open-source Natural Language Toolkit (NLTK) for symbolic and statistical natural language processing. However outcomes from this algorithmic analysis proved less meaningful than detailed reading and manual coding of the text.

Results from the third case study

A total of 54 people were selected for participation in the Nuclear Citizens' Jury, with four reserves in case of illness or emergency. In actuality, 52 people participated across the four days of deliberations, as well as facilitators and experts. Figure 15 was presented in the jury's report (Nuclear Citizens' Jury 2016, p1), making data about who was represented transparent for other South Australians, which participants repeatedly articulated was an important principle.

Figure 15: Demographics of the Nuclear Citizens' Jury



This infographic shows that the participants were evenly split between genders, however in fact the jury report listed that there were 27 male participants and 25 female participants (Nuclear Citizens' Jury 2016, p1). There was a mix of age groups, though there were double the number of people more than 60 years of age than less than 25. There were 42 people living in Adelaide and 12 from more remote parts of the state. Unlike the first two case studies and most other deliberative public engagement with science projects researched in this thesis, participants in this case study were also sampled for whether they owned or rented their home. There were 16 renters and 36 homeowners who participated.

The participants deliberated what parts of the report of the Nuclear Fuel Cycle Royal Commission that “everyone needs to discuss” (Nuclear Citizens’ Jury 2016), everyone in this case referring to all South Australians. They also developed a set of principles for engagement (Nuclear Citizens’ Jury 2016, p2). The principles were:

- 1) Legitimacy – a legitimate decision must include all people.
- 2) Inclusivity – there must be continual community consultation.
- 3) Transparency – all sources of information must be freely available.
- 4) Consequences – due consideration must be given to people, our economy and our environment.
- 5) Accountability – decisionmakers are accountable to the community.
- 6) Consider the future – further considerations and more debate of other options.
We must also consider future generations of South Australians through all stages.
- 7) Distribution – Potential economic benefits must be shared and accessible to everyone.
- 8) Ethical – all decisions should be ethically and morally sound - what’s good, what’s right, what matters.

The report also stated that additional research, economic analysis and public engagement were required for South Australians to be able to make an informed decision (ibid, p2).

Participants developed a list of key issues to consider, which were presented in the report. The first issue was safety. Jurors unanimously agreed that all South Australians needed confidence in regulatory processes for their own safety, as well as that of the

environment and for future generations. They noted the importance of discussing safety and security due to the long time scale of a high level waste storage facility (ibid, p4).

The second issue was health. The jurors' report noted that most of the Royal Commission expert witnesses were agreed on the relative safety of the storage containers. However the report said that uncertainty around the impacts on flora and fauna of radiation warranted further study.

The third issue was waste storage. The report noted the geological and seismic stability of many parts of South Australia and that storage containers for nuclear waste were rigorously designed. However jurors stated "the public needs to be confident in an independent, transparent regulator, particularly in light of regulatory failures both internationally and locally" (ibid, p5). Jurors wanted lessons learned abroad through experience, as well as international standards and research data, to support introduction of an Australian regulator.

Transport was another highlighted issue. The report noted that used fuel is transported internationally using specialised casks which are designed to withstand extreme impacts. Accidents during transport that have occurred have not released harmful radiation. In the transport section of the report high level waste was explained as used fuel rods from a nuclear reactor that have been cooled down in wet ponds and then stored above ground for decades. The report noted that nuclear waste requires permanent storage as radioactivity can be harmful for hundreds of thousands of years (ibid).

Trust, accountability and transparency were issues highlighted together. The report said factors promoting trust and transparency should be built into the design of regulatory

systems. It noted that storing used fuel would affect future generations of South Australians, as well as options for other nations for their nuclear waste management. This consideration of both local and transboundary impact will be analysed in later chapters. In the section about trust, accountability and transparency, jurors directly addressed other South Australians reading it:

“In coming to your own view on whether we should pursue a storage facility for used fuel you need to consider that moral and ethical responsibilities are central to the ownership and integrity of our decision. Do we think these actions are good? Do we think they are the right decisions?” (ibid, p7).

The report stated that it is an international principle of radioactive waste management that a society generating waste is responsible for managing it. However it also noted that nations unable to manage waste within their borders can contract radioactive waste management to another country. This was followed by discussion about the need to build trust and avoid past mistakes, such as the Maralinga weapons’ testing, which lacked communication and engagement with affected communities (Mazel 2006). Jurors not only discussed trust and accountability among local people, but also with countries from whom South Australia might take radioactive waste.

Also within the trust, accountability and transparency section there was discussion about legislative changes needed to move forward. The Nuclear Fuel Cycle Royal Commission recommended the removal of clauses in South Australia’s legislation that prohibit public money being used to encourage or finance construction or operation of a nuclear waste storage facility. The Nuclear Citizens’ Jury (2016, p7) report noted that further investigation could not proceed without change to this legislation. Federal legislation prohibiting licensing of uranium processing for commercial developments, as well as prohibitions on nuclear power, were also discussed. It is not clear from the

structure of the report why legislative issues were included under the trust, accountability and transparency heading, however this will be analysed based on transcripts from the Nuclear Citizens' Jury in later chapters.

The trust, accountability and transparency section concluded with two questions for consideration: "what do we as a community need to do, to ensure that any measures put in place are what we want?" Then "will the public have the opportunity to review any proposed changes to legislation?" (ibid) These questions reflect the iterative nature of the process, with town hall meetings and a second citizens' jury following the report of the first. Later in the report a list of questions was presented - it is not clear why these two questions were isolated from the final list and instead placed within the trust, accountability and transparency section, though some analysis based on transcripts of deliberations will be presented in later chapters.

The next section of the report was about economics, benefits and risks for the state. It highlighted recommendations 1,2,3,4,5, and 11 from the Royal Commission report (Scarce 2016), which related to potential economic benefits from the nuclear fuel cycle. The most discussed in the Nuclear Citizens' Jury (2016, p8) report was Recommendation 11, specifically about establishing used nuclear fuel and intermediate level waste storage and disposal facilities in South Australia. The jury's report noted that the commission's report found a facility had potential for significant income for the state, but noted risks and uncertainties that require more research. Further research to make an informed decision would need more financial investment by South Australia.

The jurors said this further research and investment was needed before any pre-commitment with "client nations" (ibid). The citizen's report said further research may determine that the project was not viable, but noted the commission's report that

suggests a strong possibility it would be viable. The need for client nations to pre-commit with a payment to cover expenditure costs was then discussed. The jurors highlighted the intergenerational nature of the project and stated the importance of ongoing economic benefits, discussing a state wealth fund. The report noted varying views between expert witnesses on the project's economic viability and remaining questions about economic modelling in commission's report that would need to be resolved "before we can feel comfortable progressing to further involvement" (ibid). The economics, benefits and risks section of the report was characterised by uncertainty and remaining questions, indicative of upstream engagement.

The Nuclear Citizens' Jury (2016, p9) report then listed a page of questions for consideration, the final page before inviting all South Australians to participate in next stages of deliberations. These questions were:

- 1) What benefits can be made available to South Australia now and in future generations?
- 2) How can we be sure that the economic analysis completed by the commission is robust?
- 3) How will the South Australian 'brand' or external reputation be affected and how will this have an effect on tourism and trade?
- 4) What reliance is there on other countries to 'pre-commit' to storing high level nuclear waste at a fixed price?
- 5) How will the benefits be realised and how will the wealth be distributed?
- 6) How do we incorporate rapid change in future technologies such as nuclear fuel recycling in the next generation of nuclear fuel reactors?
- 7) What are the workforce opportunities, skills, training and research?

These questions were followed by suggestions for recommended reading and a call to action for everyone to get involved.

These questions demonstrate how the issue was framed as one local to South Australia, however with transboundary links. The need to other countries to pre-commit to fund the project was noted, after questions about benefits for South Australia and impacts on the state brand and reputation. The second question reflected uncertainty about economic modelling. Question six was about distributive justice, while question seven was about the rapid technological change. The final question was about workforce, training and research opportunities associated with the project. Concluding the jury report with questions, particularly questions about uncertainty, indicates the upstream nature of these deliberations.

Discussion

Discussion of results is ongoing throughout this thesis, however certain issues are highlighted here given their relevance to results more than the tradeoffs presented in the next three chapters. The first is considering whether participants are influenced by the personality and characteristics of experts presenting to them, as well as the content presented. Reason and emotion are discussed briefly and will be elaborated upon in later chapters. The value of deliberations for informal participants is briefly noted, then the length of deliberative processes is discussed. The leads into discussion about whether participant confidence and satisfaction with information and time available is associated with better quality decisionmaking.

How much does who is presenting information influence decisionmaking?

Voting outcomes from studies about research funding, both the UK study (Rowe et al. 2010) on which the first case study was based as well as the Australian adaptation, revealed the most junior male researchers garnered the most public support and the most senior female researchers the least. The poor result for the most experienced female in the UK study was confounded by the fact that she presented a deliberately dubious project; a factor that was removed from the Australian experiment. Small sample sizes limit the significance of this finding. However, it is worth flagging given evidence about barriers facing women in science (Clark Blickenstaff 2005; Murray and Graham 2007) and how ethnicity biases research funding decisions (Ginther et al. 2011). Interestingly in the Australian experiment, the most successful proposal was pitched by a scientist with a foreign (North American) accent, whereas in the UK study (Rowe et al. 2010), the most successful proposal was pitched by the only presenter who was not white (not discussed in the cited article, but known from author participation in that study). This was despite the majority of participants in the Australian study having Australian accents, and the majority of participants in the UK study being white. This finding may be of interest to those researching otherness (Krippendorff 2010) but is beyond the scope of this thesis. Although voters consciously justified decisions by discussing the content of proposals, unconscious bias based on characteristics of presenting scientists cannot be ruled out.

Reason and emotion

The first case study aimed for diversity among experts, which was not an aim in the second and third case study. In designing the first case study I sought diverse presenters

to showcase the diversity of people who work in science and seek funding for research. Participants' reasons for their decisions appeared to be based on the content of proposals, consistent with reasoning used to make real research funding decisions. However, research shows that biases affect decisions, often unconsciously (Burgess et al. 2007; Fiske 2002; Green et al. 2007; Jost et al. 2004; Krieger 1995). No results from the three case studies explored the affective nature of decisionmaking, which is important for considering framing. There were some ways to analyse this indirectly, for example noting that twice as many people used "I think" compared to "I feel" in the first case study. However emotionality was not explored directly. Emotional factors are likely stronger when proposals are communicated by a person rather than in writing. Actively acknowledging diversity and its role in decisionmaking may also improve participants' satisfaction (Abdel-Monem et al. 2010). Diversity and inclusion of emotion in deliberative processes is further discussed in the next chapter.

Informal participants

The value of informal participation should not be underestimated (Bell et al. 2009). Volunteers and venue staff can also benefit from participation. At one event, a waitress became demonstrably engaged in the event, actively seeking out presenting scientists after formal deliberations to discuss a scientific question. Powell and Colin (2008) said that public engagement events should happen away from research centres so they are less intimidating to those generally disengaged from science. This also potentially benefits venue staff who may have little exposure to science, as opposed to those working in science centres who are exposed daily.

Lengths of deliberative public engagement with science

The ideal length of a deliberative public engagement with science process is debatable. This is an important consideration for access to resources, fair deliberations and efficiency, discussed as criteria for good deliberative processes in the introduction of this thesis. Considerations for and against shorter and longer processes are presented below.

Participation for a few hours during a meal is more realistic for time-poor participants than multi-day jury processes. Even busy people need to eat. Researchers have discussed the role of incentives in participatory processes (Powell and Colin 2008). Providing a meal during deliberations, as happened in all three case studies, is an example of this. As well as meal incentives, participants in the third case study were financially compensated for their participation. Mansbridge (1973) observed that the time spent in participatory decisionmaking alienates many people, particularly when there is little social incentive. Research has found providing a free meal or paying for child care are incentives that can strongly influence participation (Kleinman et al. 2011).

Organisers benefit from shorter events because of less costs. The costs of hiring a venue, arranging catering, and coordinating speakers, participants, and staff are minimised. Dietrich and Schibeci (2003) questioned the value of consensus conferences, arguing the cost and effort involved can be prohibitive, particularly for reiterative processes. Elster (1998) said in the book *Deliberative Democracy*:

“Whereas scientists can wait for decades and science can wait for centuries, politicians are typically subject to strong time constraints, in two different senses. On the one hand, important decisions tend to be so urgent that one cannot afford to discuss them indefinitely. On the other hand, less important decisions do not justify lengthy deliberations. As I observed earlier, the

importance of time in political life implies that, in addition to deliberation, voting as well as bargaining inevitably has some part to play.” (ibid, p9).

Decisionmaking about science funding, at the interface of science and politics, does not wait for decades or centuries. So exploring the practicalities of how to make such decisions in efficient timeframes is worthwhile.

However, voting events during a meal allow minimal time for deliberation and limited consideration of new facts and viewpoints. There is a tradeoff between accessibility and the benefits of a more in-depth deliberation process. An empirical study of making decisions using the Delphi technique found that four rounds of questions and feedback were generally the best; two iterations rarely achieve a stable outcome (Erffmeyer et al. 1986). So the optimal amount of time and available information for decisionmaking is debatable and depends on context.

Satisfaction with information and decisions does not necessarily correlate with good decisions (O'Reilly 1980; Stumpf and Zand 1981). Participants have differing perceptions of time's value (Elster 1998). The amount of time people have to make decisions affects how much information they can handle before feeling overloaded (Buchanan and Kock 2001; Eppler and Mengis 2004). Some psychological research suggests having too much information can negatively affect decisionmaking (Iyengar and Lepper 2000; Wilson and Schooler 1991). People may make better decisions subconsciously than they do with conscious deliberation (Dijksterhuis 2004). There may be inconsistencies between which methods participants prefer and which result in best decisions (Erffmeyer and Lane 1984; Tjosvold and Field 1983). The amount of information or time preferred for decisionmaking may vary with age (Cassileth et al. 1980) or culture (Gambetta 1998), suggesting different deliberative processes may

favour different demographics. There are diverse academic and practical perspectives on ideal lengths, depths, and types of deliberations, as well as how these variables shape decision quality. Given this, concise deliberative processes have a place within the landscape of deliberative public engagement methods alongside more lengthy ones.

Results from three case studies of deliberative public engagement with science have been presented in this chapter. Recruitment varied throughout the three case studies, yielding different results. The first was targeted at those without science degrees, but participants were still more educated than Australia's average. The second was Australia's first public deliberations about synthetic biology, however the majority of participants were from Adelaide, because this is where deliberations happened and there was no financial support for participants' travel to the event. In contrast, the third case study was deliberately limited to South Australians and participants were financially compensated for their time. This third case study used stratified random sampling, whereas the first used snowball sampling and the second was left to self-selection. Whether stratified random sampling does lead to better representativeness will be discussed in the next chapter.

The first two case studies used a shorter method than the third which had benefits for participants and organisers in costs in money and time, but penalties regarding the depth of deliberations. Many participants were concerned about the length of deliberations in their feedback about the first case study.

As well as understanding the science they were deliberating about, participants were concerned with understanding social benefits and risks. Participants in the first case study reported that their decisionmaking was influenced by potential benefits of the planned research, as well as their understanding. This was supported by analysis of the

rating of each proposal on 11 criteria. Research proposals that were better understood were rated higher. Participants indicated concern for where the benefits of research flow, for example, whether the benefits have an impact on their own community or internationally. This was reflected in the Nuclear Citizens Jury report, which discussed local benefits and risks but also the importance of commitment from other countries for the project to go forward.

Four days of deliberations in the third case study yielded the same type of results as the second case study, both of which resulted in a list of questions. So while the longer deliberative process was more comprehensive and thus may be seen as more legitimate, there is no evidence that the outcomes were of better quality than if participants had deliberated for a single day rather than four.

The result from the more downstream first case study was a clear preference, while the later two upstream case studies generated lists of questions. Results from the first case study were consistent across three repetitions of the event format with different publics. This demonstrated participants' capacity to rate research proposals on the type of criteria used in deciding what research proposals governments fund.

The method of the first case study differed from the subsequent two, in that the later case studies were aimed at recommending policy priorities, rather than making a decision about which one of three proposals they preferred. The second case study was more open, in broadly asking participants what they thought should be Australian policy priorities for synthetic biology. In contrast, the third case study engaged participants in deliberations about the Nuclear Fuel Cycle Royal Commission Report. However both the second and third case study concluded their findings with a list of questions.

Quality of deliberations and unconscious factors may have affected decisionmaking in unobserved ways. However, these biases have been shown in existing decisionmaking processes. Other researchers have shown inefficiencies in research funding processes, even suggesting some randomisation of funding allocations as an improvement. Given that participants who were surveyed valued the deliberative process and their participation in decisionmaking, deliberative public engagement with science about research funding is preferable to randomisation. Civic benefits from public involvement in prioritising research proposals may improve the value of grant allocation processes in democracies. Unconscious factors and quality of deliberations impact expert decisionmaking as well as public methods.

Results from the three case studies, combined with literature review, led to development of the framework of tradeoffs discussed in the next three chapters. Further results in the form of open-ended responses to survey questions and transcripts of deliberations are used in the following chapters. The Appendix of this thesis is a transcript of results from the second case study. Transcripts from the third case study are available online and thus have not been replicated in this thesis.

Open access to results from the Nuclear Citizens' Jury has allowed its inclusion in the case study of this thesis. I was an investigator of the first two case studies, which involved research protocols including ethical approval through universities. In contrast, the third case study was a government initiative that had transparency as a principle, as part of a policy of reforming democracy. Inclusion of the Nuclear Citizens' Jury as a case study in this thesis is an outcome of transparency, indicating the value of the principle.

Chapter Four: Representative versus inclusive participation

Introduction

This chapter argues that while representation and inclusion are both ideals in deliberative public engagement with science, they are better understood as a tradeoff. Ideally in theory, participation will be both representative and inclusive. However in practice considering them a tradeoff in the design of a deliberative process is more practical. Full inclusion is impractical in most cases, so either a specific group will be engaged for inclusion in the broader public sphere, or representation will be claimed.

Three case studies are analysed for how participants were recruited and whether method and results indicated representation or inclusion as the tradeoff. The first was aimed at including the perspectives of people without scientific expertise in research funding decisions. The second considered the demographic representativeness of participants, which was found lacking in some ways. The third case study unequivocally prioritized representation rather than inclusion. The second and third cases which aimed for demographic representation did not consider discursive representation. A literature review of other case studies in deliberative public engagement found some instances of recruitment for discursive representation, as well as of recruitment focused on specific groups, discussed later in this chapter.

Representative processes may appeal to organisers because a single iteration of deliberations may be cheaper, even when factoring costs of recruiting via random stratified sampling. Then representativeness can be claimed to justify costs, through the

argument that outcomes reflect public opinion or the interests of all. However this claim is dubious, given that representation can be claimed on either demographic or discursive grounds, but rarely both. Thus gaps in representation are easily revealed.

In situations where deliberations are framed narrowly enough to support full inclusion, power imbalances during deliberations still impact inclusion. Engaging specific groups, such as Aboriginal Australians in the third case study, promotes inclusion where otherwise people may be excluded or their voices overwhelmed by a majority of alternative perspectives. Inclusion through engaging with specific groups has no claim for broader representativeness. Thus instances of deliberations should be considered part of a decentred deliberative process, which involves more investment in deliberations among other groups, given lack of representativeness.

Diverse iterations of deliberations among different groups of people may prove more costly than a representative process, but may be more legitimate given greater meaningful participation. When iterations of deliberations have linkages between them, allowing sharing of knowledge and comparison of outcomes, the value of a deliberative process is enhanced.

Stakeholder or public engagement

In stakeholder engagement, people are invited to participate because they have a particular stake in the process, so can be contrasted with disinterested or unengaged publics who are invited in other methods of recruitment in deliberative public engagement with science. Chilvers argued public engagement practitioners are divided into two groups, depending on whether they advocated for a stakeholder model of participation or a public model:

“different groupings were evident between those advocating a stakeholder model of participation (engaging citizens who represent the interests of others in groups to which they belong) as opposed to a public model (involving individual citizens who represent only themselves and who have little prior interest and engagement with the issues in question).” (Chilvers 2010, p8)

Given this thesis is focused on deliberative *public* engagement with science, based on Chilvers’ argument above, it should be focused on models that engage disinterested or unengaged publics rather than stakeholders. Case studies one and three were focused on publics in this sense, while case study two relied on a more self-selecting sample of participants. Self-selection means that participants may be representing particular interests, which may not be disclosed in recruitment.

Defining representation and inclusion

Reviewing literature about what is meant by inclusion and representativeness in STS allows some conclusions to be drawn about recruitment methods used in deliberative public engagement with science. Methods focused on representation typically seek to recruit a cross-section of a given population and may intentionally exclude experts or stakeholders. Methods focused on inclusion typically recruit a particular type of participant, such as members of a group otherwise underrepresented, or stakeholders. When inclusion is focused on members of a particular group it is designed as part of a broader democratic agenda. While an isolated event focused on a particular group cannot meet democratic ideals, it can contribute to decentred deliberative democracy if other deliberative processes focused on other groups happen as well.

Representation used in this chapter refers to the status and values of participants and how they are positioned within a deliberative process. Recruitment approaches focused

on representation are based on the idea that a group of proportionally representative people meeting face-to-face and interacting in a single forum can represent the decisionmaking of broader society. Proportional representation is typically concerned with the demographic makeup of a deliberative group, for example whether there is a balance of genders and mix of ages and ethnicities. This demographic proportionality can be contrasted with discursive representation.

Discursive representation is concerned with the diversity of perspectives and positions held by participants. Democracy requires discussion of a range of perspectives on policies, but not that perspectives get represented in proportion to the number of people with them. Proportionality may be undesirable because it can lead to groupthink and the silencing of marginalised voices. Discursive representation is more concerned with a diversity of ideas than a diversity of demographics. Dryzek and Niemeyer (2008) argued that discursive representation was important particularly for transboundary issues, such as synthetic biology discussed in this thesis. Discursive representation depends on assessing people's attitudes in recruitment, rather than only their demographic characteristics.

Benhabib (1996, p71) said that deliberative democracy is a procedure for becoming informed, as no individual can foresee all perspectives nor possess all information relevant to a decision affecting all. Deliberative democracy involves people in collaborative learning about the issue discussed, based on the range of knowledge and perspectives participants can contribute. So discursive representation is more aligned with deliberative democratic ideals than representation based on demographics. This is because discursive representation depends on having a range of perspectives from which people can arrive at mutual understandings. If people have diverse demographic

characteristics but the same opinions and perspectives, their deliberations will not result in collaborative learning. However demographic representation is more common in deliberative public engagement with science, because it is perceived as more legitimate. This legitimacy will be discussed in more detail later in this chapter.

Including diverse communicative actions

How a diversity of perspectives become discourses relates to what type of communication is considered appropriate in deliberative democracy. Deliberative democracy depends on norms of reasonable discourse and communicative rationality (Chambers 1996; Bohman and Rehg 1997). Communicative rationality is related to communicative action, a theory developed by Habermas (1984) in which people interact in deliberations to arrive at mutual understandings, typically through argumentation. However methods of communication based on argumentation, while associated with rationality and reasonable discourse (Rawls 1997, p767), have been critiqued as exclusionary.

Young was critical of traditional conceptions of communicative rationality in deliberative democracy. She argued that putting aside interests was not possible, arguing such interests are “relationally constituted structural differentiations” which can be important resources in democratic decisionmaking (2002, p7). She argued people were wrongfully excluded through segregations based on economic and social differences, as well as geographical and political boundaries (ibid, p8). Other researchers have likewise argued that people should not be expected to put aside their own interests for deliberative democratic processes (Mansbridge et al. 2010). Making participation in deliberations contingent on a particular type of communicative action can be a barrier to inclusion.

Young (2001, p5) argued other types of communicative action had a place in deliberative democracy alongside reasonable discourse. She argued public address, rhetoric and narrative were valuable, particularly for groups historically excluded from public discourse. These types of communication help to situate experiences and explain meanings in ways that allow participants to be swayed by other positions (ibid, p5).

What type of communication is appropriate in deliberative democracy is a contested issue.

Democratisation as inclusion

Dryzek (2000, p85) argued for the idea of democratisation as inclusion. He argued that as franchise, scope and authenticity in deliberations increased, inclusion improved.

Franchise is the proportion of a population who can participate in politics. Scope is the range of issues within democratic control. Authenticity is how much participation and control are not symbolic but substantive. Franchise may be misleading; while people may symbolically have voting rights, in practice they may not have the power to substantively participate in deliberations. Exclusion can manifest through physical and geographical barriers, but also through lack of voice in public deliberations. This is why democratisation goes beyond franchise to include scope and authenticity.

Substantive deliberative processes encourage reflection about values and articulation of perspectives that are open to change, rather than mapping of pre-existing positions (Dietz 2013, p14084). So authentic deliberations involved people being open to new perspectives. If people are not willing to consider the perspectives of others with whom they are engaging in communicative actions, then deliberations are not authentic.

Inclusion is important in democratic systems, particularly in places like Australia with compulsory voting, as part of the idea that everyone's perspectives matter, not just those who are most engaged or most knowledgeable. Whether voting is compulsory or not, democracy involves "the intermingling of expert and lay cultures" (Jasanoff 2010, p197). The inclusion of everyday perspectives alongside expert ones is a feature of democracy as opposed to technocracy, which will be detailed in the next chapter. Compulsory voting systems are inclusive from a franchise perspective, however may be lacking in scope and authenticity.

Inclusion projects, such as a biobanking project in Chicago discussed later in this chapter (Lemke et al. 2012), seek to give voice to those who may have historically been excluded from the public sphere (Fraser 1990). When there is state support for engagement of specific groups to target power imbalances it may be referred to as associative democracy. For example, in the third case study, specific resources were developed to engage Aboriginal Australian communities (Your SAY Nuclear 2016d). Dryzek (ibid, p90) was wary of associative democracy, whereas Young (2002) was in favour of government support for associations of underrepresented groups to improve inclusion. This demonstrates that tensions exist even within theories of inclusion in deliberative democracy.

Decentred deliberative democracy

Young's (2001) idea of decentred democracy is important for analysing inclusion and representation because it challenges notions of who should be included and who should be represented. Decentred democracy relies on iteration of a process among different groups of people in different places. Climate change adaptation projects based on STS and deliberative democracy theory (Phadke et al. 2015) analysed later in this chapter

explicitly facilitated neighbourhood and community-level dialogues. Their rationale explicitly drew on Young's (2001, p46) decentred conception of politics and society in designing the study. The third case study was designed to include iteration, given that the first citizens' jury was designed to inform town hall meetings across the state and a second citizens' jury following statewide meetings. Iteration is important because of changing states of knowledge in science and technology (Owen et al. 2012) as well as promoting inclusion through repetition of deliberative democratic processes in diverse communities.

Review of recruiting for deliberative public engagement with science

Purposive recruitment was the most popular method in a scoping review of public engagement related to health priority setting (Mitton et al. 2009, p222). Purposive recruitment was followed by self-selection and random sampling as the most popular methods (ibid, p224). Unlike random sampling methods, which are representative, purposive recruitment methods seek to engage a specific group, who may otherwise be underrepresented in public discourse about an issue. Purposive methods prioritize inclusion. This does not mean that everyone is invited to participate, as with self-selection methods. Rather a particular type of person or community is sought for engagement, typically because otherwise they may have been at risk of exclusion.

Biobanking is a topic for which inclusion is particularly important given relationships between ethnicity and genetic diversity (Tutton 2008) and thus is an apt issue for analysing methods for inclusivity. The term biobanking refers to the collection of biological samples, usually human and sometimes limited to specific populations (Hewitt and Watson 2013). Deliberative public engagement about biobanking is able to

be analysed given enough reports of deliberations in different countries to compare and contrast. As highlighted in the introduction of this thesis, transparency is valuable beyond the objectives of a given process. Reports of several deliberative processes on biobanking have been valuable as a group able to be analysed together.

Longstaff and Burgess (2010) discussed recruiting for representation in public deliberation about the ethics of biobanks in Canada. They critiqued random sampling methods that were concerned only with demographics, arguing that randomly sampled participants may not encompass all interests and values relevant to biobanking. Instead they recruited specifically for a diversity of interests, life experiences, values, and styles of reasoning (*ibid*, p213). After analysing eight different recruitment options they chose a recruitment strategy aligned with their objectives for deliberative public engagement. Their objectives were understanding different views, respectful engagement, informed deliberation, and diverse discursive styles and experiences (*ibid*, p221). They opted for stratified sampling via random digit dialled recruitment, yielding a group of participants that was stratified for provincial health regions and a range of demographic categories, but also for diversity of perspectives. This combined discursive representation with demographic representation.

A deliberative process in Australia was based upon the approach developed by Canadian researchers. The aim of the Australian study was discursive representation, which they differentiated from proportional representation. The Australian researchers argued the objective was not a statistically representative sample but rather a sample diverse in public perspectives. They explicitly sought to include minority and marginalised voices, focused on perspectives previously unarticulated in the “sphere of public discourse” (Molster et al. 2013, p213). To promote equity of access participants

were offered \$100 AUD per day to participate in the four-day deliberative forum; travel and accommodation expenses were also reimbursed. The four days were split over two weekends with a fortnight in between, to allow time for participants to learn about biobanks and deliberate and develop mutual understandings (ibid, p214). The researchers clearly articulated that they were not concerned with demographic representativeness of participants but rather inclusion of a diverse range of perspectives.

A deliberation about biobanks in Chicago was held over two days. Recruitment in the Chicago process was specifically of English-speaking, African American primary caregivers of children receiving care at two urban healthcare facilities serving different socioeconomic communities (Lemke et al. 2012, p1029). Participants were offered between \$50-250 USD depending on how much time they spent participating. In contrast to other biobank deliberations reviewed, the Chicago deliberative engagement was structured as focus groups; participants received a financial bonus if they attended all four sessions (ibid, p1031). This incentive to participate in multiple iterations of deliberations about the same issue reflects the values of decentred democracy discussed earlier.

Another study using focus groups in Australia (Wortley et al. 2016) sought community views and perspectives on public engagement processes in health technology assessment (HTA) decisionmaking. This was not specifically about biobanking, though biobanking is a health technology. This involved six focus groups in Sydney and was specifically focused on whether the public, as opposed to patients and carers who are stakeholders in health technologies, should be involved in HTA. Results indicated that participants wanted public engagement in HTA to include a diversity of individuals (Wortley et al. 2016), not only stakeholders. Health technology stakeholders including

patients and carers are normally involved in HTA - this study differed in explicitly focusing on public perspectives as distinct from those of consumers and carers. This process was focused on representation because it was deliberately seeking to engage a disinterested public, whom they argued were representative of public views, as distinct from those invested in the health system through participation as patients or carers.

These HTA deliberations differed from the three biobanking deliberations in different countries because they were focused on a general public, rather than on a specific group, as in the Chicago case, or a sample with discursive diversity, as with the Australian and Canadian biobanking cases. The HTA deliberations were explicitly about representing public views and thus focused on representativeness rather than inclusion. In contrast the Chicago case was firmly focused on inclusion, specifically of a group who may otherwise have not engaged in public deliberations about biobanks. This type of inclusion of a specific group differs from the type of inclusion prioritized in the Canadian and Australian examples. In these examples the emphasis was on inclusion rather than representation, because they sought to include as many perspectives as possible. Whether these views were representative of the broader population was less relevant than including many perspectives.

Deliberations about biobanking can be contrasted with deliberations about natural resource management (NRM), which tend to focus on specific stakeholder engagement due to fears that inadequate inclusion of local interests could weaken processes (Parkins and Mitchell 2005, p533). Important stakeholders are typically considered to be those with agency in an initiative and tenure over resources (Ross et al. 2002). When full inclusion is not the aim, participants are more likely to be selected because they are influential in local planning and decisionmaking, rather than being statistically

representative of the larger community (ibid, p534; Hull et al. 2001, p329). So deliberations about NRM tend to focus on inclusion rather than representation. However because NRM, particularly land management, has been historically associated with imbalances of power, full inclusion is a challenging aim.

Conflict in NRM about tenure over resources can echo feminist critiques of attitudes to bodily property ownership (Dickenson 2007). While there are clearly people with greater local interests, those who actually wield decisionmaking power over those interests may not be representative of those affected. Researchers in Canada analysed the contribution of the National Action Committee on the Status of Women on the issue of assisted reproductive technology in the country (Montpetit et al. 2004). In contrast to other studies reviewed, their research discussed deliberative processes by and with women's groups over a period of 15 years but without details about methods and recruitment.

Deliberations confronted the "values and priorities of an economically stratified, male-dominated, technocratic science" (Montpetit et al. 2004, p145). Reproductive technology is a form of health technology, allowing contrast with the Australian study described earlier in which public participation, beyond stakeholder participation, was seen as valuable (Wortley et al. 2016). Whether men acting as democratic representatives in the public sphere should be making decisions about technology primarily affecting women's bodies is an example of the contested legitimacy of representativeness.

NRM issues and health technologies can have a local focus, either sited in a community or in an individual's body, which makes clear who should be included in deliberations. Other issues are inherently transboundary and thus it is less clear who should be

included. A climate adaptation planning process in the United States explicitly drew on STS scholarship about deliberative democracy. From this STS literature they focused on three areas of concern, the first of which was the “micropolitics” of deliberation, including issues of representation and inclusivity (Phadke et al. 2015, p64). They were critical of demographic sampling methods for similar reasons as Longstaff and Burgess (2010), arguing that demographic categories chosen for statistical purposes “often do not account for how identity, history and culture are shared by social groups whose members may transcend typical age, class and gender categories” (ibid, p64).

These climate adaptation deliberations drew on Young’s (1990; 2001) work on decentred deliberation in their design of neighbourhood dialogues, with the intention of engaging underrepresented voices and perspectives (ibid, p64). Decentred deliberative democracy promote inclusions through extinct of a diversity of processes, each of which can be focused on engaging a particular underrepresented group. Young noted it is important such local deliberations focused on specific groups have linkages, so they are part of the broader public sphere and not isolated.

In transboundary issues full inclusion is not practical in any single deliberative process. So a single process can seek representation, or alternatively may focus on inclusion of an underrepresented group in dialogue in the broader public sphere, as with the Chicago biobanking deliberation. If focusing on inclusion, organisers narrow the transboundary nature of an issue, either by localising it to a group small enough for full participation, or by narrowing participation to a particular group who would likely be excluded in a process left to self-selection. In both cases no claim of representativeness is possible - rather such processes acknowledge their deliberations sit within a broader deliberative democracy. Acknowledging that a process is not representative, but rather aiming to

include particular voices or groups who may otherwise be excluded from the public sphere, reflects the values of Young's notion of decentred democracy.

Representation and inclusion in the first case study

The first case study explicitly sought to recruit participants without a background in science to support inclusion of non-experts in making science funding decisions. It was explicitly modelled on a UK deliberative democratic event about prioritising research proposals, in which researchers reported that participants lacked demographic representativeness (Rowe et al. 2010, p236). They discussed ways the participants were not demographically representative due to for example ethnicity and education level, but did not delve into discursive representation as did some other processes reviewed (Longstaff and Burgess 2010).

A common problem in public engagement with science is that the same audiences are repeatedly attracted, whereas other types of people are rarely engaged. Left to self-selection, participants are more likely to be middle class and well-educated, to be members of political parties or lobby groups, and to have previously interacted with their local government than the average citizen, thus already having greater chance for input into policy than other members of the public (Adams 1989). This knowledge established decades ago holds true today, evidenced in case studies of this thesis and beyond. For example, researchers of participants in Austrian public engagement events found a very strong bias towards people with high formal education and belonging to the cultural Austrian majority (Felt and Fochler 2010).

Given this problem, fair recruitment should be an important consideration for organisers of public engagement with science.

“If policymaking were always just a matter of finding neutral, technical solutions to common problems, then disproportionate involvement of educated people would be desirable because of their superior competence. More often, however, policy choices depend on interests and values not universally shared. Education is statistically associated with higher income and occupational status, as well as with distinctive cultural tastes. Thus, participation based on intensive, deliberative forms of citizen participation will usually neglect the needs and desires of more plebeian members of the population, unless the process is carefully structured to counteract the normal bias in favour of the well-educated.” (Nagel 1992, p1969)

In an effort to address this problem, a method of counteracting this bias was tested in the first case study by actively seeking participants without a background in science. Participants were able to specify seating preferences and register to participate in a group. Allowing participants to register in groups, in line with snowball sampling methods, drew individuals unlikely to attend such an event normally. It is probable that “seed” participants who drew others to participate were more actively or confidently involved in deliberation at the event; so although such recruitment draws a wider range of people, power imbalances in participation may result. Given that snowball sampling recruits participants through social networks, isolated individuals were unlikely to be engaged using this method.

The “proof of concept” method of the first case study highlights several areas of improvement and further research. The criteria on which participants rate proposals could be modified. Different recruitment methods could improve representation. The impact of presenter diversity on decisionmaking could be further explored. Venues could be compared, with informal participation in mind. Deliberations among publics and experts or policymakers could be compared. The impact of deliberation length and

depth could be explored, drawing on research in psychology, political science, and behavioural economics.

The first case study aimed for inclusion in the same sense as the Chicago biobanking deliberations - in the sense that a particular type of person, in this case people with no background in science - might otherwise be excluded from public deliberative engagement with science, unless specifically targeted. While demographic diversity within this group was considered, the emphasis was on inclusion of non-scientists rather than whether the group were representative of the Australian population.

Although successful in attracting people without a formal background in science, participants in the first case study were more educated than average, and particular age groups were underrepresented, as discussed in the previous chapter. This is consistent with experiences in other participatory funding projects, such as health budget deliberations in Oregon in which participants were largely white, middle class and able-bodied, despite the program being specifically designed for lower income people (Young 2002, p680).

Longstaff and Burgess (2010, p213) recruited specifically for a diversity of interests, life experiences, values, and styles of reasoning. The first case study used snowball sampling to attract people without backgrounds in science, but did not consider diversity of life experiences and beyond basic demographics. So while the aim of including people without science was achieved, seeking a diversity of perspectives within the group as well as seeking a diversity of demographics could have improved recruitment.

Participants' thoughts on representation and inclusion

Some participants discussed issues of representation and inclusion in responding to a survey question about whether or not such deliberative public processes would be useful for making real funding decisions. For example, reference to the general population deciding suggests that public participants represent the decision preferences of a general public better than experts.

“General population gets to decide how fund are used. Relevancy to real life!”

Rather than considering a general public, one participant was concerned specifically about taxpayers.

“Taxpayer's money towards research; excellent that taxpayers are given the opportunity to be presented various research propositions and various research propositions and selected.”

This idea that people who pay tax should have a say because they fund the research differs from democratic ideals in which everyone should have a say regardless of their earning capacity. Representative democratic ideals were evident in one response about politicians representing the interests of their constituents.

“Outside the square - we are not the normal fund-givers. We do have influence on the politicians and their views.”

The potential of using such methods to engage diverse groups of people, consistent with decentred deliberative democracy discussed earlier in this chapter, was raised by one participant.

“They would be useful to get public opinion and awareness. It would also be useful in getting info from diverse groups of people.”

In contrast to valuing the perspectives of diverse groups of people in separate deliberations, the value of getting diverse people to engage with each other was noted by one participant.

“These events bring together many facets of society but sadly some very important building blocks of science are usually seen as boring or unimportant to the layman and only useful for the expert.”

The positive of bringing together different facets of society was contrasted with the negative idea that laypeople found science boring or unimportant. The five responses shared above were from a survey question about whether or not such deliberative public processes would be useful for making real funding decisions. These were a minority of responses, indicating that the majority of participants had other issues in mind rather than representation and inclusion when thinking about whether such processes were useful. Other such issues are analysed in later chapters.

Representation and inclusion in the second case study

In contrast to the first case study, which explicitly sought to engage people without a background in science, there were no restrictions on who could participate in the second case study. Of the three case studies this was the least concerned with either demographic representation or inclusion; it was more focused on piloting the method including interactive live voting. Given this was Australia’s first public deliberation about synthetic biology, the aim was more about raising awareness of a policy issue and developing a list of public policy priorities. It was more concerned with discursive representation than demographic representation. Encouraging participants to think about synthetic biology from different perspectives was reflected in presentations from a lawyer and ethicist as well as two scientists.

Recruitment of policymakers among a general public

In contrast to the first case study that sought explicitly to engage people without science degrees, this case study sought to recruit participants with expertise in policymaking, given it was the first public deliberative forum about synthetic biology in Australia and funded through the Australian Government's NETS-PACE program. Recruitment did not place restrictions upon those with any type of qualifications; as well as some South Australian Members of Parliament and public servants, there were lawyers, science students and others with areas of expertise relevant to synthetic biology research, regulation and policy. This process reflected values of inclusion used in NRM discussed earlier, in which including stakeholders is a priority. There was no prior mapping of who were stakeholders that necessitated inclusion; invitations to participate were publicly distributed and people self-selected.

People wary of science were not included in results

Self-selection meant that, although participants were encouraged to deliberate about a range of perspectives on synthetic biology, negative perspectives may have been unintentionally excluded. Of the 77 participants 45% agreed that science has mostly positive impacts on society, while the other 55% were neutral (Ankeny and Smith 2011, p11). This indicates lack of inclusion of groups or individuals within Australian communities who may have more negative views towards science, or social pressure to report a positive or neutral attitude to science during the forum, despite voting anonymity via the CLiKAPAD technology.

Less positive views have been expressed by for example the Friends of the Earth Emerging Tech Project, which was part of a civil society collaboration that produced a

report *The Principles for the Oversight of Synthetic Biology* (Hoffman et al. 2012), describing synthetic biology as extreme and calling for a precautionary approach. As discussed in previous chapters, activist approaches to engaging with science emerge when people feel that ‘invited’ methods of engagement may not be worthwhile or when they do not feel invited to them. It is possible that people sharing perspectives reflected in the Friends of the Earth project were participants in the second case study, however these perspectives did not emerge in the results. This reflects discussion about power imbalances earlier in this thesis.

In contrast to the first case study, in which people expressed their attitudes on surveys, results of which were not made public, the second case study used e-voting technology that made results transparent to all participants in real time. This may have affected people's’ participation. For example upon seeing that 45% of participants were of the attitude that science has mostly positive impacts on society, the 55% who were neutral may have changed their behaviour assuming that half of the group in which they were deliberating had more positive views than they had.

Knowing information about fellow deliberators’ attitudes may have led people to change their communicative actions and their choices for argumentation. Greater transparency in the form of sharing polling responses throughout the forum may have had implications for how people engaged. As well as information presented by experts, participants in the second case study had another source of data to inform their deliberations and communicative actions: polling results they witnessed live as their deliberations unfolded.

The second case study was intended as a proof of concept for future public deliberative processes about synthetic biology (Ankeny and Smith 2011, p7), with future iterations

including different voices. Lack of government support for further iterations means that there has been little inclusion of diverse voices in public debate about synthetic biology in Australia. This has left a larger role for activists in deliberative democracy as articulated by Young (2001). It could be argued that the views expressed by Friends of the Earth are not representative of typical Australians, however. However as emphasised in the methods for example of Longstaff and Burgess (2010), discursive representation is an important aspect of deliberative democracy.

Deliberations about synthetic biology in Australia have moved out of the public sphere and into more private realms, indicated by military funding (Defence Science Institute 2013). This has implications for representation and inclusion, given that lack of public information limits public deliberations. The second case study may have contributed to the closing down (Stirling 2008) of deliberations about synthetic biology rather than opening up as was intended. The aim of the second case study as precursor to future public deliberations about synthetic biology was not realised. It was part of the NETS-PACE program funded through the Australian Government's innovation portfolio, which was discontinued by the following government.

Inclusion and representation in Science and Technology Engagement Pathways

A related aspect of the NETS-PACE program was a multi-stakeholder process leading to a Science and Technology Engagement Pathways (STEP) framework. The aim of STEP was to “increase inclusiveness and representativeness” (Russell 2013, 575) by broadening participation within stakeholder groups, rather than involving only self-appointed representatives. STEP was co-designed by stakeholders and members of the public in separate stakeholder workshops with industry, government, researchers and

public; the public workshop involved 45 participants (Marks and Russell 2015, p 99).

The 45 people were recruited by an independent market research company to represent a demographic range reflective of the Australian population based on geography, gender, age, ethnicity and disability (Russell 2013, p572). However the Northern Territory and Western Australia were not represented (ibid). The 45 people had their transport, meals, accommodation, and a cash incentive provided to participate at a venue on the Gold Coast for a day and a half (ibid).

The first of the stakeholder workshops engaged with public health, public interest, union and non-governmental organisations (NGOs), some who had expressed criticism of policies for emerging technologies (Russell 2013, p570). The meeting in Melbourne in April 2010 involved 14 participants from 12 NGOs (ibid, p571). Later workshops in Canberra engaged respectively with natural and social science researchers; representatives of industry and enterprise in emerging technologies; and representatives of federal and state agencies and regulators (ibid, p571).

Each stakeholder group nominated a working group to represent them at the multi-stakeholder forum, which in practice was individuals self-nominated from each group (ibid, p572). The multi-stakeholder forum to develop a STEP framework then brought together the representatives of each stakeholder group with the public participants. In August 2011 the multi-stakeholder day-long event was held at Old Parliament House in Canberra (ibid, p573). The framework was tested in a series of forums around Australia called 'STEP into the Future', focused on different topics including synthetic biology (Marks and Russell 2015, p100).

Marks and Russell (2015, p103) said the project's role in policy development remained at the periphery of policy, with the role of managing negative responses to emerging

technology. The program represented people who might otherwise be excluded from government policy about emerging technologies. It included “‘neglected’ voices and perspectives” and aimed to tackle exclusions and power asymmetries (ibid, p109).

Rather than being a forum to make policy about emerging technologies, it was a space for representing a diversity of voices about it - even if that representation did not lead to inclusion in policy.

STEP activities were described as spaces for “assembling and making visible these different matters of concern” (Marks and Russell 2015, p104), revealing normative assumptions but without power to change them in policy. Lack of policy influence was evaluated as the major weakness of STEP (ibid, p107); it ended after a change of government in 2013. Difficulties of measuring policy influence from science communication initiatives has been documented by other researchers (Kurath and Gisler 2009, p566). While the STEP project improved representation of diverse voice in public discourse about policy regarding enabling technologies in Australia, this did not translate to inclusion in policy.

Representation and inclusion in the third case study

In contrast to case study two, case study three was state funded, specifically by the Government of South Australia. Whereas case study two and the NETS-PACE project of which it was part struggled to demonstrate impact on policy, case study three was focused on deliberations about a particular policy decision.

Of the three case studies this was the one for which representativeness was most clearly communicated, as part of its framing as a group of citizens deliberating about a specific policy issue. The value of their individual roles in the process were scrutinised, for

example with *The Australian* newspaper reporting that each jury member cost \$7000 (Puddy 2016). Case study three was the first citizen's jury in a multi-part deliberative process. It was explicitly designed to be representative, whereas the next phase of the multi-part process was designed to be inclusive, through town hall meetings across the state.

Despite the method being designed for representativeness, there was uncertainty about whether participants were only representing themselves or representing all South Australians. The Premier highlighted their representative role in introducing the jury process on the first day, declaring participation was “a massive privilege on behalf of the broader community” (Spark and Cannon 2016a, p3). However uncertainty remained present among participants in the Nuclear Citizens' Jury themselves. On the final afternoon of deliberations, this uncertainty was evidenced in clarifying questions to the jury from the facilitator: “when you talk about ‘we’, who is the we? Is that ‘we, the jury’? Or ‘we the South Australian community’.” (Spark and Cannon 2016d, p332). This indicates uncertainty about representativeness late in their deliberations.

The facilitator later said “all the people here represent the South Australian community” (Spark and Cannon 2016d, p334), though the transcript recorded a juror's response to her earlier question as indistinct. Emphasis in the Nuclear Citizens' Jury (2016) report, about inclusion of more South Australians in subsequent iterations of deliberations, discussed earlier in this chapter, indicate that they did not feel their representative decision was sufficient for a legitimate policy decision. Whether or not authorities or facilitators stated their representativeness, a key outcome of the jury was the need for more people to be involved in decisionmaking.

Facilitators encouraged jurors to document a diversity of views and capture questions that were unanswered (Spark and Cannon 2016d, p214) on the morning of the last day of deliberations. Their efforts at including a diversity of views were constrained by organisational aspects, which will be discussed in the next chapter. One example of including a diversity of views was a juror having time to explain to the Premier on the first morning of deliberations their belief that renewable energy alternatives to nuclear had not been sufficiently considered.

“The report lets us be clear on the facts of nuclear, and that was the terms of reference for the Royal Commission, but I just find it lacking in the alternatives to nuclear. I know there's regard to renewables, I would say, in here, and, you know, just reduction in consumption, better housing design. You know, there's lots of other policy options before we head down a nuclear energy path, and I just found that, you know, hasn't been explored enough for me.” (Spark and Cannon 2016a, p9).

Despite renewable energy alternatives being articulated early in the process and discussed the following day (Spark and Cannon 2016b, p103-107) it was not mentioned in the Nuclear Citizens' Jury report. More debate of options was a principle the jury listed in their report, as discussed earlier in this thesis. However what other options had been discussed in deliberations were not recorded. So while there was concern within the deliberative process about documenting a diversity of views, alternative options were not well captured in the final report, which was presented as a consensus document. This will be revisited in the subsequent chapter about the tradeoff between public and organisational ownership.

Discussion

Gregory (2002) argued that particularly for issues with environmental and health implications, tradeoffs bring up emotional and ethical issues that are fundamentally

challenging to think about. McKenzie's (2014) PhD research on science communication values in Australia found that conflicting values of stakeholders were difficult for practitioners to reconcile. This thesis argues that good deliberative public engagement with science involves transparent documentation and communication of values underpinning decisionmaking, including in the design of deliberative processes. As was discussed in the introduction (Delgado et al. 2011), presenting areas of tension as tradeoffs helps practitioners to make decisions in design that they will otherwise have to navigate in process. Being clear about priorities before starting deliberations is consistent with principles of transparency and accountability.

Including specific groups rather than representative citizens

Gaps in representation in case studies demonstrate why deliberations focused on including specific groups may be more legitimate, however targeting specific groups requires ongoing iterations of deliberations to include other groups and build linkages between deliberations. Young (2001, p10) argued for decentred deliberative democratic processes, given risks of hegemony situating power in particular places.

The combination of biobanking deliberative processes reviewed in this chapter fit with Young's (2001, p46) decentred conception of politics and society. The Australian and Canadian processes focused on representing the maximum number of perspectives in discourse. In contrast, the Chicago process focused specifically on a particular group whose views may have been otherwise been left out of the public sphere. However the depth of viewpoints among countless other specific groups are not represented in the literature of deliberative democracy for biobanking policy and ethics. This is not a criticism of the studies reviewed, rather a reflection on the tradeoffs between inclusion and representativeness in democracy. Given the democratic ideal that everyone has a

voice, can deliberative democracy be achieved only once everyone's perspective on every issue has been heard? The impracticality of this demonstrates why deliberative democracy is a process rather than an end state.

Results from the first case study indicated that people's decisionmaking was influenced by location, particularly locations of benefits. A sense of place is recognised as an influential aspect of public participation in natural sciences (Haywood 2014). Locality is a vexed issue for inclusion particularly in local issues such as NRM (Parkins and Mitchell 2005; Hull et al. 2001), but also for transboundary issues where the location of risks and benefits is uncertain. Thus deliberations in further locations would support decentred deliberative democracy, assuming there were linkages between them.

Decentred deliberative democracy through iteration

Iteration is important in deliberative public engagement with science for two reasons: because of changing states of knowledge in science and technology, as well as the tradeoffs leading deliberative democrats and activists to strive for greater inclusion and representation. Taking a mixed methods approach, with some deliberations aiming for representation and some aiming for inclusion, is ideal given sufficient budgets.

However given that efficiency and timeliness are criteria for good deliberative public engagement, as discussed in the introduction to this thesis, endless iterations are not ideal.

Even mixed methods approaches, such as the broader deliberative process of which case study three was part, are open to critique. The representativeness of participants in this case study was based on demographic factors, rather than discursive representation, as was a priority in some of the biobanking deliberations reviewed. In contrast to case

study two, which was a single forum, case study one involved three deliberations across two different sites. This was consistent with principles of decentred deliberative democracy, however many more deliberations would need to happen in many more locations before claims of consensus could be made.

An aim for inclusivity in invited engagement may be to minimise the risks of uninvited engagement. Wynne (2007) argued that invited participation, such as the methods of deliberative public engagement with science presented as case studies in this thesis, can be contrasted with uninvited participation, which includes protests and boycotts. Those not invited to participate in face-to-face deliberative processes but invited as part of the public to submit for example to an inquiry or commission, may choose protest methods of communication rather than going through the motions and technical norms of an official process (de Saille 2015).

Collaborative learning and social capital

Collaborative learning depends on what knowledge and perspectives can be interacted with (Keen et al. 2005). Inclusion of diverse perspectives increases the potential of discursive representation. So including a greater diversity of perspectives increases the potential for collaborative learning based on the range of information available.

However collaborative learning also depends on communicative actions to arrive at mutual understandings. If people have such diverse perspectives they struggle to find common ground, collaborative learning may not result.

When social capital is high in formalised groups, people's confidence in collective activities increases; however this can be at the expense of vulnerable people (Pretty 2003, p1914). Greater social capital and sense of community in a group of people in a

place improves their collective capacity, for example to manage natural resources (Pretty 2003). However this may lead to exclusion of those lacking social capital, or be part of a cycle of exclusion that needs addressing for authentic franchise (Dryzek 2000, p85).

Research indicates online deliberation can increase participants' issue knowledge and political efficacy as face-to-face deliberations can (Min 2007), however group cohesion is less likely than when people meet in person (Gastil 2000). Social capital in real-world communities is not developed through online deliberations. Transboundary deliberations such as those moderated through the internet are beyond the scope of this thesis, however their potential for supporting greater inclusion is worthy of note.

Including more perspectives in policy

While the STEP project improved the diversity of voices represented in public discourse about enabling technologies in Australia, this did not translate to inclusion in policy.

Likewise diverse voices in the third case study, such as those advocating for alternatives to nuclear, were included in the process but not in the outcome. These are challenges of deliberative public engagement with science methods focused on consensus, which can be contrasted with those using polling methods, such as in case studies one and two.

However polling methods, particularly transparent ones in which participants see results in real time used in case study two, may limit voices in other ways. Participants may not feel comfortable expressing their perspectives upon realising their view is a minority.

These are some of the myriad of ways in which processes aiming to reflect a diversity of views may be hindered in practice.

This chapter has argued that while representation and inclusion are both ideals in deliberative public engagement with science, they are better understood as a tradeoff. Full inclusion is impractical in most cases, so either a specific group will be engaged for inclusion in the broader public sphere, or representation will be claimed. Three case studies were analysed. The first attempted inclusion of the voices of people without scientific expertise in research funding decisions. The second assessed the demographic representativeness of participants, revealing gaps. The third clearly prioritized representation. In the second and third cases, demographic representation was considered, not discursive representation. A literature review of other case studies in deliberative public engagement found some instances of recruitment for discursive representation, as well as of recruitment focused on specific groups.

The cost of representative processes may be justified though the argument that outcomes reflect the interests of all. However this claim is easy to critique, given that representation may be on demographic or discursive grounds and is rarely both. Even in cases of full inclusion, power imbalances during deliberations come into play. Engaging specific groups, such as Aboriginal Australians targeted in the third case study, promotes inclusion among people whose voices may not be heard in a broader policy process. Focusing on inclusion in this way means that instances of deliberations should be considered part of a decentred deliberative process, which involves more investment in deliberations among other groups, given lack of representativeness. Diverse iterations of deliberations among different groups of people may prove more costly than a representative process, but may be more legitimate given greater meaningful participation. When iterations of deliberations have linkages between them, allowing

sharing of knowledge and comparison of outcomes, the value of a deliberative process is enhanced.

Chapter Five: Public versus organisational ownership

Introduction

The second tradeoff explored in this thesis is public versus organisational ownership in deliberative public engagement with science. Can ideas of public power in decisionmaking be reconciled with the realities of organisational control? Whereas the previous tradeoff of representative or inclusive recruitment was a design consideration, this tradeoff concerns communication before and during a deliberative process.

Presenting public and organisational ownership as a tradeoff relates to how deliberative practitioners and sponsors frame a deliberative process to participants and other stakeholders. Deliberative public engagement with science processes are often justified in the public sphere because they give power to the people, or give public control over some decisionmaking process. However this chapter argues these justifications rarely reflect reality.

Wynne (2007) argued that public engagement with science includes invited and uninvited forms. Invited forms, such as methods of deliberative public engagement with science analysed in this thesis, have clear organising forces. There is organisational ownership in the sense that some organisation or group of individuals has power in design and process. Organisational ownership also manifests through norms and assumptions that may be unquestioned and reflected in participants' communicative actions throughout a process. Alternatively questions may arise during the process, but organisational primacy means assumptions to challenges are marginalised.

This chapter argues there is no singular public, or plural publics, separate from an organisation sponsoring or initiating deliberations. It is difficult to identify where organisation ends and where public begins. Technocracy and democracy are different ways of organising society based on different assumptions about how much power the public should have. Democracy and technocracy can be perceived as competing frames for reality, however more nuanced approaches are more practical. Defining ownership, public and organisation precedes analysing public and organisational ownership. Three cases studies of invited participation are analysed; all showed evidence of the dominance of organisational ownership, with different degrees of public power in process.

Public and organisational ownership in theory

Defining ownership

Definition of ownership in this thesis comes from Lachapelle and McCool's (2005, p281) writing about natural resource management. Ownership has several aspects, firstly "the processes by which voices are heard and considered legitimate" (ibid). Ownership involves the framing of problems, which drives underlying assumptions and guides strategies taken in deliberations. The privileging of particular voices and forms of knowledge influences how individuals interact and make decisions. Secondly, ownership relates to power to make decisions and implement outcomes. A lack of power can make participants feel uncomfortable or used (Daudelin et al. 2011). The third aspect of ownership concerns "who is affected by an outcome or action and how plans and decisions are distributed, accepted, and "owned" spatially" (ibid, p282). This third aspect is related to later discussion in this thesis about local and transboundary

issues. Ownership in this definition has three elements: being heard, having power to decide and implement, and being affected.

Claims of public ownership in public engagement with science are made even when organisational ownership is evident. McCallie et al. (2009, p28) discussed ownership in public engagement and informal science education, in the context of allowing the public to “help direct scientific investment and application”. This is helping an organisation rather than having power to control it. Public ownership or control over decisions is often claimed when in fact the public have participated in processes for making decisions or recommendations that are not binding. If there is no power to enforce the outcomes from deliberations of participating publics, organisational norms may continue without change. This is discussed in further detail in the next chapter.

Irwin (2001, p6) discussed democracy in biosciences, describing a UK forum about the future of the agriculture and food in which “ownership of the results explicitly belonged to the citizens themselves”. However the forum was designed by an expert group “with experience in genetics, food, policy-making and citizen participation” (ibid, p5). These experts designed the forum of a random selection of 12 British citizens, who met over 10 weeks. The citizen participants “chose particular topics for discussion”, directed the presentation of expert witnesses and drew their own conclusions (ibid, p6). Thus while communication about the project suggested participants owned the results and had control over the process, their coming together to generate results and go through a process was designed by experts, indicating organisational ownership.

Defining public

Understanding what and who we mean by ‘public’ is an important prerequisite to assessing outcomes of deliberative public engagement with science. Researchers have argued that engagement outcomes and how publics are created have been studied at the expense of considering how participants inhabit and appropriate deliberative spaces (Felt and Fochler 2010, p221). In this chapter how publics engaged in deliberations in each case study is considered as well as how they were created, after articulation of the meanings of public and organization.

The term ‘public’ is diversely defined in studies about public engagement with science. A review of public participation in healthcare priority setting included several terms alongside ‘public’ in literature review. The extra terms were stakeholder; consumer; community; communities; citizen; lay; layperson; laypeople; layman; taxpayer and grassroot (Mitton et al. 2009, p221). This indicates the range of ideas that ‘public’ can encompass, from an individual to a community and from perspectives of consumers or citizens.

Horst and Irwin (2010, p16) suggested that a market discourse is gaining strength within the governance of science and technology in Europe; the notion of public citizens may likewise be losing favour to the concept of market citizens in Australia. This is relevant given Wynne’s (2007) concern about situating STS work in broader political economic contexts. Dove et al. (2012, p5) discussed the idea of the biological citizen in this age of pharmacogenomics: “entrepreneurial citizens who are autonomous, self governing and increasingly conceptualising themselves in biological terms and ostensibly taking responsibility for their own health.” This idea is at the border between the notions of consumers and citizens, given that biological citizens have power to contribute to

research development beyond simply paying for it, but exclude people in ways similar to the idea of market citizenship, based on their lack of ability to pay.

Participants' contributions to deliberative public engagement with science costs them time and energy; incentives influence who participates and why. Thorpe and Gregory (2010) argued that participation in public engagement with science is a form of immaterial labour, blurring distinctions between production/consumption and economy/politics. For this thesis, ideas of democratic participation are used to frame who participates rather than ideas of market citizenship (Root 2007), consumerism, or of taxpayers as distinct from the broader public.

Wilsdon and Willis (2004) wrote an influential report that argued for upstream 'see-through science', drawing on the work of Wynne (2005) who argued that public engagement typically happens downstream in a process. This report did not define the public who were to have greater influence on policy. The report discussed the "scientific elite" (Wilsdon and Willis 2004, p13) and policymakers (ibid, 18) as well as discussing the public repeatedly, without defining it. That the public were different from policymakers and scientists was implied in the theme of the report, calling for greater public participation in science and policy decisionmaking.

Wilsdon and Willis (ibid) used public in two senses. In the sense that the public were people different from scientists and policymakers, but also as a quality of something done or known openly. This latter sense of meaning is evident in the report, for example "what can happen when the underlying social visions of key players (such as Monsanto) are not made visible and opened up to public deliberation" (ibid, p36). This open doing or knowing can be further deconstructed (Stirling 2008). Beck (2000, p226) argued for the "opening up to democratic scrutiny of the previously depoliticised realms of

decision-making”, critiquing the epistemological and legal systems in which debates about risk happen.

Some researchers differentiate publics that participate in engagement activities with disinterested publics who do not participate, which can become a perception among participants themselves as they gain knowledge (Felt and Fochler 2010). Kearnes and Wynne (2007) discussed the politics of enthusiasm, arguing that ambivalence can be an engaged rather than passive mode of relating to an issue. Most people are part of a disinterested public in relation to some issues and stakeholders in others. Likewise they have non-public knowledge about certain matters, particularly their own life experience, which they may choose to share in the public sphere, or prefer to keep private.

Benhabib (1996, p76) argued that civil society is public not in the sense of being open for universal access, but in the sense of being part of public conversation. This is an example of what Habermas (1989) referred to as the public sphere. Benhabib argued perspectives of stakeholders such as civil society representatives were artificially separated from public perspectives. When are people representing an organisation and when are they simply being themselves? What implications does this have for power and ownership?

Tocchetti and Aguiton (2015) discussed how an agent of the United States Federal Bureau of Investigation (FBI) participated in a DIY biology meetup along with the general public. He had “a rather different look from the other participants” (ibid, p826), leading organisers to ask who he was and be given his FBI business card. They asked are FBI agents DIY biologists like any other participant? Given the agent was present as part of his work, arguably not. His public presence at the meetup may have impacted the behaviour of other participants. What of university students? Were they not public

because of their participation in research? Defining who are public participants reveals norms and assumptions about what we mean by publics, as distinct from stakeholders, organisers or sponsors.

Mitton et al. (2009, p222) analysed public definitions and recruitment methods used in healthcare priority setting. The public could be defined for 167 out of 190 cases (ibid, p223); 23 were uncodable (ibid, p222). They divided definitions of public into three categories: patients, service users or consumers; representatives of organised groups; and individual citizens. The fourth category 'multiple publics' was an amalgamation of the other three. Most of the cases reported multiple publics being consulted. A single public was twice as likely to be the public as citizens rather than stakeholders (ibid, p223). A third of the cases paid particular attention to recruiting disadvantaged populations or groups (Mitton et al. 2009, p222), as advocated by Young (2001; 2002) discussed in the previous chapter.

Excluding people from public definitions because of involvement in an organisation is problematic, because people may be participating in their own capacity rather than as a representative of an organisation. People maintain their own thoughts and reasonings; people may be part of several organisations, some of which may have conflicting organisational norms. For example, people may participate in hackerspaces in their spare time because hackerspaces' ad hoc organisation allows them to use their skills in ways different to their day jobs (Toombs et al. 2014). Organisational norms of commons-based peer production in hackerspaces (Kostakis et al. 2014) may differ substantially from commercial workplaces. Whether an engineer were participating in a deliberative process from their position as a member of their workplace or as a member of a hackerspace could lead to different outcomes.

Likewise people may choose to communicate an alternative point of view than their own life experience for arriving at mutual understanding or for the sake of argument. Seeking to understand another's position is an important part of communicative actions working towards mutual understanding. Developing common ground involves taking on new information and shifting perspective to a place where collaborative learning can happen (Baker et al. 1999).

Mitton et al. (2009, p223) noted that it is possible that people chosen to participate as individuals may still speak to or represent their understanding of a group view, rather than articulating their personal experience. Arguing for alternative worldviews or values positions rather than relating personal experiences is a rational form of discourse (Habermas 1996). People can present alternative ways of organising ideas to improve pools of arguments in discursive deliberations. Communicative actions on behalf of others is well studied in environmental politics, given that nonhuman species or ecosystems do not otherwise have a voice in decisions impacting them (Eckersley 1999). Challenging organisational norms through presenting alternative perspectives can be done by those within an organisation.

Young (2002, p688) argued that people and organisations move between different positions depending on issues at stake, who is interacting and their perceptions of possibilities for action. The question of who is doing the separating - who is framing publics versus experts to decide whose perspectives should be heard in deliberations - is important for considering public versus organisational ownership.

Defining organisation

Organisation has two relevant meanings for this thesis. It refers to an institution or group of people working together based on shared norms. It also refers to a physical or mental process for sorting information and perspectives. Organisation in this mental sense means observing links in a complex network of relational interdependencies, interactions and processes (Silbey et al. 2009). The sponsoring organisation of a deliberative process is usually transparent - less clear are the cultural and epistemological assumptions built into deliberative processes.

Structural inequality in public deliberations can be embedded because participants may consider it part of unalterable social reality. It “concerns the conceptual and imagistic frame for discussion, which often contains falsifications, biases, misunderstandings, and even contradictions that go unnoticed and uncriticized” (Young 2002, p686). This is public rather than organisational ownership of structural inequality, in that it is enforced regardless of sponsoring organisation.

Organisations such as corporations, governments and universities coordinate people’s activities to achieve particular objectives. Bogner (2012 p519) discussed the “primacy of organization”, using examples from deliberations about stem cell research to show how alternative frames and ethical questions were marginalised in keeping the process on track, based on the expectations of the moderators and organisers. A deliberative process, in which people listen, deliberate and come together in conclusion usually at predefined time points, involves procedural organisational norms that influence how much time is available for discussions.

Bogner (2012, p508) argued that self-organisation by citizens who are affected by or concerned about an issue is a characteristic of ‘real’ participation. However other researchers have argued that such self-organised participation may be unrealistic given lack of resources (Powell and Colin 2008). Methods of invited participation reflect organisational ownership through processes designed before public participation begins. Thus reflection and transparency about these organisational norms is important.

Democracy and technocracy

Democracy and technocracy are different ways of organising society, the norms and values of which may be unquestioned. Democracy, particularly deliberative decentred democracy, is presented in this thesis as a desirable way of organising society; technocracy has been used as a contrast to democracy in STS literature. Participants in deliberative public engagement with science may be acting through different understandings of how society is organised, which may be revealed as mutual understandings develop in process.

Technocracy implies control by people who are part of organisations with scientific and technical norms. Fine and Owen (2005) studied Californian air pollution policy to present environmental planning and modelling processes lacking in public participation as technocracy. They critiqued assumptions embedded in subjective modelling presented as objective science, calling for greater discussion of subjectivity and technocratic value judgements. Kimura (2010, p132) discussed tension between democracy and technocracy in food governance, specifically citizen participation in food certification in Japan. Citizen’s perspectives were contrasted with technical ones. Neither of these STS case studies defined technocracy in using it as a contrast to

democracy, indicating unquestioned assumptions about norms and values in how society is organised.

Abraham and Sheppard (1997) defined meanings of these contrasting ideas in focus groups about how medicine should be regulated. They said a technocratic approach favours governance “dominated by technically trained experts by virtue of their specialized knowledge”, while a democratic approach emphasised “broad public participation in the management and government of technological risks” (ibid, p140). Thus an organisation sponsoring deliberations sits within a broader organisational frame: one in which technical experts are in charge of decisions, or one in which the public participate in risk management and governance. A frequent argument for technocracy is the impracticality of awaiting democratic decisions in all cases.

“Any process affording community members a role as informed participants in decision making must also confront the facts that relevant information may simply not exist, that it may by its very nature be inaccessible at the time decisions must be made, and that it may undergo consequential changes during the period of time over which a policy decision or act of consent will expose people to hazards.” (Ottinger 2013, p256).

Such arguments for technocratic approaches reflect the challenges of upstream engagement, which will be discussed in more detail in the next chapter.

Irwin (2006, p301) argued that polarisation between technocracy and democracy should be replaced by more nuanced understandings. In writing about the politics of climate change Lahsen (2005, p159) challenged the dichotomy between technocracy and democracy, based on Beck’s (1992a; 1992b) writings on risk in society. In revisiting his own work and responding to critiques of it, Beck (2000, p211) challenged constructivist frameworks in which “no one is able to define and declare what really ‘is’ or ‘is not’”.

This is why criteria for good deliberative public engagement include access to resources, including access to information or experts. Democracy does not do away with technological expertise, but is concerned with sharing it for decisionmaking. Challenges of sharing it in a timely and efficient manner are discussed in the next chapter, focused on outcomes.

Multiple frames

Deliberative democracy involves shifting from technocratic ideals to those of public ownership of decisions. Irwin (2006, p302) was cautious of “institutional claims to have embraced a new social contract of dialogue, transparency and consultation”. He drew on Wynne’s (2002, p472) argument that democratic influence over science and technology was undermined by how “the dominant culture reinvents and extends its unreflexive founding commitments” despite critique and public disaffection. Such normative assumptions have been questioned in the Australian context (Marks and Russell 2015). Irwin (2006, p302) argued more fundamental changes in practices and underlying cultural and epistemological assumptions were needed before “the transformation from deficit to democracy can be complete”. The idea of complete transformation is incongruous with Irwin’s calls for nuanced understandings rather than polarisation between technocracy and democracy.

There is no single public; likewise there is no organisation in control of deliberative engagement with science that can be isolated from the participating public, or the cultural and epistemological assumptions embedded in the society in which the organisation operates. Dichotomies between technocracy and democracy, or understanding and acceptance, or public or organisational ownership, depend on

framing. Thus exploring how ownership is understood in this thesis follows, to inform discussion about what is meant by public versus organisational ownership.

Power in design

Powell and Colin (2008, p129) argued that most engagement projects are top-down exercises and that this seemed “somewhat unavoidable”. By this they mean experts initiate, organise and facilitate projects, making use of organisational resources that lay people lack. Irwin (2001, p6) reported that ownership of the results of an agricultural forum belonged to the citizens, but Powell and Colin’s (2008) argument that engagement is inevitably controlled by experts holds true in the sense that experts designed the study and recruited the citizens. As will be discussed in the next chapter, explicit citizen ownership of the results may mean the results are not used by those with the power to implement any suggested actions.

Wehling (2012, p43) described contrasts between invited or sponsored organised types of participation, and uninvited types that he argued typically have greater impact.

Uninvited types such as protests or boycotts tend to be in reaction to organisational frames, thus are designed to impact them. Invited types intentionally or unintentionally perpetuate organisational norms, thus have less potential for transformative change.

Lezaun and Soneryd (2007, p288) note that organisers can be among those moved by a process. They characterise the goal of organisers as mobilisation, “they want to move participants, to affect them and their views... to generate narratives of change, even conversion, as the key utility of deliberation” (ibid, p293). However participants in deliberations may also be influencing organisers, which can also generate organisational change.

The idea of invited participation was popularised by Wynne (2007), referring to processes that are sponsored or initiated by institutions, such as the case studies described in this thesis. In contrast, uninvited types were led by “mobilized counterpublics” in civil society, such as environmental or patient groups (Wehling 2012, p46). Invited participation methods include consensus conferences, focus groups, citizen juries, public consultations, whereas uninvited engagement includes protests, campaigns and lobbying (Delgado et al. 2011, p833). Consistent with Young (2002) discussed in the previous chapter, Wehling (2012, p52) argued that in democratic societies, marginalised or disadvantaged groups must be able to express their own specific self-interests, to make sure they are not misrepresented by others.

Power in perspectives

Wehling (2012, p46) was critical of invited deliberative processes for unorganised laypeople. He argued such processes separated the perspectives of laypeople from those of interested and engaged civil society who may be opposing mainstream science. Framing the lay public as separate from already engaged groups more easily aligns their views with those of the sponsoring organisation. Whether ‘the public’ are recruited as random citizens, as described by Powell and Colin (2008, p131) and Irwin (2001, p6), or whether they are able to participate as representatives of stakeholder interests, can indicate how the sponsoring organisation frames the public.

Lezaun and Soneryd (2007, p288) observed that processes appear differently depending on whether they are observed from the point of view of organisers and their consultants or from those consulted. Participants can thus frame a deliberative event themselves - either as anticipated by a sponsoring organisation, as in Powell and Colin’s (2008) case, or unexpectedly. Lezaun and Soneryd (2007) critiqued static images of the public, as

well as organisers' delineation of a distinction between stakeholders and the general public. They discussed "eventful" public engagement (ibid, p281) in which participants generate surprises and unanticipated events. They describe this as social responsiveness, as opposed to mere consultation (ibid, p282). When participants are able to shape deliberative processes in ways that sponsoring organisation did not anticipate, it suggests public ownership. This happens beyond the organisational design stage, during the deliberative process.

Power in process

Within invited forms of participation there remain varying levels of how much power participants have in a process. This can depend on whether participants have opportunities to challenge information presented, and what part of an organisation invites participation, "who is listening and ultimately responding to the public" (Abelson et al. 2003, p244). Powell and Colin (2008, p130) argued that the power to influence is a critical aspect of public engagement and that organisations and publics should both have some degree of control. Young (2001, p50) argued that the normal condition of democratic debate is a struggle and this struggle is a process of communicative engagement between citizens. The field of struggle is uneven, so fair and open deliberative processes should actively promote inclusion.

The idea of communicative engagement relates to that of communicative action.

Communicative action was a theory developed by Habermas (1984) about communication based on reason. Communicative action was about reaching mutual understandings, for which moments of insight came from understanding one another's reasoning (ibid, p27). Research has indicated people are influenced by their values more than others' rational arguments (Kahan et al. 2011), but communicative action remains a

compelling frame for interpreting how people deliberate. Communicative action is a process by which people arrive at collective thought based on reasoning, not force. Reasons can be presented through debating interactions (ibid, p25) or arguments themed around a problem. Communicative action transmits and renews cultural knowledge (ibid, p137) through patterns.

“cultural patterns of interpretation, evaluation, and expression serve as resources for the achievement of mutual understanding by participants who want to negotiate a common definition of a situation and, within that framework, to arrive at a consensus regarding something in the world.”
(Habermas 1984, p134).

Before writing tomes on communicative action, Habermas (1970) wrote about the risks of systematically distorted communications. This relates communication to the system in which it happens. If there is latent strategic reproduction of meaning rather than a participatory production of meaning, communication is systematically distorted (Deetz 1992, p173).

In reflecting on Habermas, Bohman (2000) argued a test of legitimacy is not only whether people’s opinions on topics being deliberated can be heard, but also whether they can initiate deliberations on new topics. Young (2002, p684) argued that activists are sceptical of even the most inclusive deliberative processes because they are subject to constraints that perpetuate unjust norms. Thus such processes cannot meet the ideals of Habermas’s communicative action, for which equality is a prerequisite. However communicative action is a valuable ideal for deliberative public engagement with science because it establishes the values of developing mutual understandings and collaborative learning. Ideals of equality may be unrealistic, so being transparent about how power dynamics may have impacted communicative actions is important.

Ownership in the first case study

Power as organisers

Like Powell and Colin (2008, p131), during case study one I was employed as a university staff member in a genomics centre, meaning that I had more organisational resources than participating publics. Furthermore in recruiting participants and sharing information about how the project was part of my postgraduate graduate research, I was given power as the chief investigator and people actively supported my leadership in design and discussion. Recruiting participants via snowball sampling meant that many participants knew me via one or two social network links, if not firsthand. Network centrality has clear links to power (Ibarra 1993); positioning within a network also influences how committed people are to those with whom they are exchanging (Cook and Emerson 1978). My power as an organiser in the first case study was evident.

I was heavily invested in the success of my research and some people participated because it was my research, rather than because they were disinterested citizens (Evans and Plows 2007) ideal for deliberative democracy. I was affected by the process, in the sense of Lezaun and Soneryd (2007) discussed earlier. The three presenting scientists had power in the design of the deliberative events and were affected by their participation. The events were designed to fit within their busy schedules; the timing allowed for the scientists to prepare their presentations until they were comfortable with them.

The deliberations culminated in participants voting on which of the three scientists' research proposals they would prefer to fund. Although it was an research experiment rather than a real funding activity, the scientists were sharing their passions with the

world and being ranked on their presentations. The scientists had strong ownership over their research proposals and were heavily engaged in the events. As organisers, the scientists and I were influenced by participation - this was notable in discussions with the scientists between three iterations of the process. Organisational changes from the process emerged from individual changes we experienced or collectively shared, rather than the outcomes of voting.

The study was designed for public participants to vote on one of three options; they had little opportunity to influence the framings of the decision. As noted in the first chapter, participants could have abstained from voting or voted in some informal way, however no-one did. The participants were engaged enough to vote effectively and as results from surveys in Chapter Three showed, most would be keen to participate in such a process again. However their participation was limited to what Russell (2014, p7) described as “the ‘pointy end’ of decisionmaking, where issues are already tightly framed around a narrow set of questions or considerations”.

Fixed frames

There were cultural and epistemological assumptions embedded in the process. A core premise of the deliberations was that scientists propose research to be funded. The traditional process of peers and experts reviewing proposals was being challenged through exploring the potential of public decisionmaking about research funding. The underlying idea that scientists propose research for funding and then produce research outputs was unchallenged in the deliberative process, despite a publication about the process (Smith 2014a, p2) citing research indicating that scientists often produce research before being funded for it (Graves et al. 2011, p4). An alternative approach that would be less top-down (Powell and Colin 2009) would be publics deliberating about

what research they would like to see happen, then for scientists to do research based on research proposals generated by the public.

There was strong organisational ownership given that scientists presented research proposals based on work they were doing within organisational norms of plant science and genomics. Broader ethical issues about the use of technology in plant breeding, or Australia's reliance on a small selection of crops for food security, were beyond the scope of the deliberative voting. They were raised in deliberations, but they were marginalised in the process of keeping the event on track, as Bogner (2012 p519) described in discussing the primacy of organisation. This indicates the forum had strong organisational ownership, in which public participants played their role in the manner requested, as discussed in Chapter Three. There was no expectation that the public should take forward the outcomes - rather it was clear that the organisers and presenting scientists should use the outcomes. We were accountable for taking forward outcomes, public participants were not.

Invited participation as experiment

Bogner (2012, p507) described invited public participation as lab experiments, in contrast with public participation as protest. He characterised invited participation as events organised by professional participation specialists and carried out under controlled conditions. He said they were rarely linked to public controversies, to the pursuit of political participation, or to the experiences of people directly affected. While the first case study was organised by a participation specialist under controlled conditions, it was directly linked to public controversy. As discussed in Chapter One, the rationale for the project was that scientists were frustrated about the state of public dialogue about biotechnology, specifically genetic modification in agriculture. The

deliberations were about the experiences of people directly affected, given that the presenting scientists were presenting their own research proposals. However as per Bogner's (2012, p507) characterisation of lab experiments, it was "set up as a research project and observed from start to finish by the team of researchers who are present throughout".

Participants' thoughts on public and organisational ownership

Participants answered a survey question about whether or not they thought such events would be useful for making real funding decisions. Qualitative open-ended responses to this questions revealed a diversity of thoughts on issues of public and organisational ownership discussed above. One participant concisely articulated shared benefits:

"Sharing the insight, sharing the sense of community involvement."

However most participants discussed a specific focus, whether a public or organisational one, sometimes in contrasting ways. For example, one discussed the power of democracy while another asserted the importance of government consultation.

"Democratic - more power to the people."

"If this project is attempting to cater to SA [South Australian] government which funds but is not meant to be catered for so much, consultation at least is important."

Seven participants mentioned influence, which relates to power and ownership. The meaning of influence differed between contexts. One asserted participants' influence on politicians.

"Outside the square - we are not the normal fund-givers. We do have influence on the politicians and their views."

One participant thought that organisational independence was valuable and was hopeful about the potential for influence.

“People who have no ties financially or politically can make an objective point of view and hopefully have an educated influence.”

Another participant shared this concern about independence, worried about undue influence from “vested interests”.

“Would ease citizens' concerns about scientific research, taking it out of forums where vested interests have undue influence.”

Another thought public participation would influence funding towards less commercially-oriented projects.

“Would: because it would change/influence the focus of future funding based on public opinion ie. significant public support for less commercially orientated projects.”

Another participant discussed the accessibility of scientists linked to the ideal of public participation in decisionmaking

“I think they would be useful because (ideally) the public should have a say in how funding is spent, and all of the scientists this evening presented their research in a very accessible and public-friendly manner.”

One participant expressed concern that charismatic scientists may have influence to the detriment of others.

“Charisma can detract from solid scientific decisions. Need a more integrated approach to decision making. If one person has the public backing - and this goes on to influence policy and decision makers to the detriment of others - not a good decision making tool.”

The general public was contrasted with the scientific community in discussing understanding and ignorance:

“Useful to gain an idea of what the 'general public' feel about this type of research and the level of understanding or ignorance outside scientific community.”

Concern about the level of knowledge of participants was a theme; a range of participants highlighted the role of information in decisionmaking.

“The forums themselves would be extremely useful and informative. The issue would be the audience - having a common level of knowledge and expertise in the cities - to be able to make an informed decision.”

“It enables communities to be able to be given both information and choice as to what issues they think are more important for their money to be spent on and what issues they believe are worthy to be pursued.”

“I think they would be useful in some ways because it gives the general public an idea of what is going on in the research field and gets them thinking about what's important and what implications society's actions have. On the other hand, it is a little difficult to make an informed decision because some concepts 'go over your head' due to lack of understanding of terminology/ideas/concepts and science-based knowledge.”

“People invited to attend may not fully understand the issues and solutions presented. Also may have no science background which would affect comprehension of info presented.”

“Not enough detail. No budget.”

“Knowledge is power - the more the more!”

Some participants discussed how the process was valuable for letting people hear about research, rather than valuing participation in deliberative decisionmaking.

“Gives people a chance to hear about research that is directly related to solving some of Australia's (and the world's) immediate problems.”

“All 3 projects are worth funding. Better to inform people in what research is being done.”

A dominant theme was participants feeling there was not enough time or information to organise their thoughts comfortably and reflect as part of decisionmaking, indicating organisational ownership of the process.

“I needed to ask more clarifying questions to come to a decision. This event is a great idea - but need more information to make an informed decision, ie. more clarifying questions and time for reflection.”

“It's only a short amount of time to understand the projects so most people probably don't have a good enough understanding of each project to be able to make a properly informed decision.”

“But must go for a much longer time with more information provided to get the best decision. More information plus better spread of the information equals better decision making, ie. democracy.”

“Too brief. Too much spin, not enough depth in presentations. I don't think anyone could make a fully informed decision about the research with the level of information provided. More deliberation with decisionmakers would be required/should be used before decisions are made - I don't think this forum would be suitable for this.”

As discussed earlier in this chapter, public ownership requires time and space for participants to set their own frames, rather than conforming to organisational norms. So feedback from participants about insufficient time and information indicate a lack of public power.

Ownership in the second case study

I was co-investigator of the second case study with Professor Rachel Ankeny of the University of Adelaide. The deliberative forum was sponsored by the Australian Government through the NETS-PACE program. I was employed through government funding by the charity hosting the forum, the Royal Institution of Australia, housed at the Science Exchange venue where the forum happened. In contrast to the first case study, where participants voted on three predefined options, in the second case study participants decided through open-ended discussion what priorities should be for synthetic biology policy. Thus the second case study had greater public ownership of the design and process than the first.

Open rather than closed decisionmaking structure

Powell and Colin (2008, p132-133) said some scientists felt intimidated by public engagement due to the range of questions asked in open discussions, ranging from technical details to ethics. This range is reflected in the transcript from the second case study shared as the Appendix of this thesis, in which the first question was a technical one about where synthetic DNA comes from, while the second was about power in transboundary issues. The deliberations about synthetic biology were informed by the four expert presentations, however participants did not need to base their deliberations and decisionmaking on information from the presentations. This is in contrast to case study one, where participants' deliberations were directly focused on the three presentations by scientists and the issues raised from them.

Transboundary challenges to ownership

The transboundary nature of synthetic biology (Zhang 2013) was a challenge for participants and organisers to feel ownership of the issue the results were about. This is evidenced in a quote from the transcript of deliberations (provided in the Appendix of this thesis):

“...we realised we were discussing them on a national level how this might be controlled, and it seems to us that it’s much broader, this is international there are no boundaries, when you can order it over the internet, are we just wasting our time even discussing this here?”

Participants considering whether a deliberative processes is potentially a waste of time indicates ownership is lacking (Carson and Hartz-Karp 2005; Fishkin and Luskin 2005).

Researchers have argued that situated knowledge embedded in language and culture needs to be taken seriously in synthetic biology policy (Schmidt et al. 2009a, p6). This relates to issues of locality discussed throughout this thesis. Even if every deliberative synthetic biology policy forum across the world yielded the same outcomes in terms of discussing safety, control, transparency and public awareness, iterating the forum in different places would have value given democratic ideals and the importance of situated knowledge. Previous European public engagement with synthetic biology was critiqued for incorporating stakeholders in talking about governance, rather than embedding public opinions in the governance of research development (Zhang 2013, p6). This indicates that organisation of what is important knowledge in synthetic biology governance has already been established, with little critique or consideration of whether such knowledge reflects or contrasts public perspectives.

Challenges of transparency in private research and biosecurity

Conflicts between public versus private perspectives of ownership are common in synthetic biology, even among synthetic biologists (Schmidt et al. 2009b, p134).

However having learnt from mistakes in past biotechnology development, in some aspects the development of synthetic biology has been deliberately open and collaborative (Torgerson 2009). Synthetic biology has thus been described as an example of Jasanoff's (2004) co-production of scientific, social and legal ways of knowing and doing (Calvert 2008, p394). Lack of open information about private synthetic biology makes public ownership of deliberations about it difficult. Likewise security concerns about bioterrorism means that much synthetic biology research is restricted information, limiting the potential for informed deliberations in the public sphere. Concern about transparency was evidenced in a quote from a participant discussing their group's highest priority issue, from the transcript of deliberations in Chapter One:

“what we saw as the first policy issue is that we want transparency nationally and internationally and the sharing of information to minimise the risks”

The opaque nature of private and military research into synthetic biology means there are not only public barriers to understanding but also barriers within governance systems. Cases are documented in which regulatory agencies could not access information about products seeking approval and thus “could not critically evaluate or contribute to the decisionmaking process” (Kuzma and Tanji 2010, p104). In such cases, control by private or military organisations may be counter to public interests.

Expert influence on group decisionmaking

The policy priorities articulated by one of the groups that participated was influenced by one of the scientists in discussion outside of the scientists' presentation to all participants. In contrast to other groups who articulated top priority concerns about control and transparency, one group spokesperson described their top priority differently:

“we had a random discussion you might say. It was – to some extent assisted by Des, who was very interesting to talk to. So we talked about things other than policy for most of the discussion because it seemed more interesting, but in the last five minutes we came out with really two but then we had to add a third one. We thought that in terms of policy one of the most important things is improving the general public's understanding about synthetic biology...”

The structure of the deliberative forum in case study two involved smaller discussion groups breaking out from the large group, then reconvening to share their three top priorities for synthetic biology policy. The four experts who had presented earlier individually, then responded to questions as a shared panel, circulated among the groups to answer questions during the small-group breakout. However in this case, a scientist sat down with a particular group and engaged in discussion with them for the majority of the discussion time, influencing the direction of the group, as the speaker articulated. Rather than focusing discussion on the participant's policy priorities, the group engaged in further discussion with the scientist, which was described as interesting, but not facilitating participants' discussion about policy priorities. This is an example of power in process; the struggle of communicative engagement described by Young (2001) and discussed earlier. The small-group discussion may have been systematically distorted

(Habermas 1970) by the scientists' powerful role in the group discussions. The small-group discussions were not recorded, so no transcript is available for analysis.

Open question in design

The second case study was designed for more open discussion than the first case study. Whereas in the first case study discussion was focused around prioritising three research proposals, the second case study was an open question about priorities in synthetic biology governance. As Young (2001) argued, more open deliberations do not necessarily lead to fairer deliberations, given systemic inequalities and struggles in communicative engagement. Results indicated that experts had power in the process, beyond their privileged role as presenters and respondents during large-group discussions. Allowing the experts to roam among the small groups contributing to discussions meant that the smaller groups accessed different information, confounding understanding of how presentation of the expert knowledge contributed to decisionmaking. Their influence on the small-group discussions supports Wehling's (2012, p52) argument that disadvantaged groups must be able to express their own interests.

Ownership in NETS-PACE

The second case study was part of the NETS-PACE program, organised by public servants employed by the Australian Government (Marks and Russell 2015). The program replaced the Australian Office of Nanotechnology, which in turn replaced Biotechnology Australia (Cormick 2012, p42; Russell 2014, p1). The framing of the NETS-PACE program as 'enabling technologies', rather than for example 'risky

technologies’, is an example of cultural and epistemological assumptions embedded in the project (Marks and Russell 2015).

While STEP was supported within the government department from which it emerged, it did not have a policy mandate (Marks and Russell 2015, p103). It had a focus on “actual outcomes” and public feedback to government (Cormick 2012, p43). Actual outcomes were research rather than policy, as “policy making did not happen in STEP spaces” (Marks and Russell 2015, p105). There were multiple STEP spaces with different stakeholders and public (Russell 2014, p3), in contrast to the two case studies. The first case study had three iterations of the same format with different people, while the second case study was a single deliberative forum. The diversity of events in STEP diffused ownership.

Russell (2014, p43) reported that a challenge in the STEP approach was to elevate public participants to the status of stakeholders. This suggests that stakeholders were typically seen as those with power in the process, whereas public participants lacked power unless they were elevated. A sociologist involved in the process wrote of frustration with how scientists framed the STEP process as education, but hesitation in contradicting them (Marks and Russell 2015, p105). This indicates a lack of ownership among some participants over how deliberations were unfolding.

STEP was both “less influential and less constrained than its position in government suggested” (Marks and Russell 2015, p104). Russell (2014, p6) reported that including decisionmakers, gaining commitment from them and influencing their decisions were major challenges for the STEP program. This indicates that decisionmakers felt little ownership over the STEP program and its outcomes. NETS and the STEP program

lapsed in 2013 (Marks and Russell 2015, p110), no longer supported by the government department that funded it.

Ownership in the third case study

In contrast to the first case study in which I was lead investigator and the second in which I was a co-investigator, I had no power in the third case study. I was living overseas during the first Nuclear Citizens' Jury and returned home to Adelaide for a visit to find outcomes from a deliberative public engagement with science process on the front page of the local paper. I then discovered full transcripts and videos of the process were available online, which allowed the Nuclear Citizens' Jury to form the third case study in this thesis.

Case study three is an example of the primacy of organisation argued by Bogner (2012), p519). Framing deliberations around the outcomes of the Royal Commission marginalised alternatives frames and ethical questions, such as whether alternative renewable energy options were a better investment strategy than nuclear waste storage. Staff from democracyCo arranged who participated and how they deliberated, rather than participants organising themselves. Despite these clear organisational framings and influences, it was hoped jurors could make decisions in their role as an independent public rather than in their role as organisational participants. This was evidenced in the Premier saying to jurors in opening the process: "you will help independently frame what we should be paying attention to" (Spark and Cannon 2016a, p4). Jurors' ability to independently frame deliberations was limited by organisational restraints on the process, including time and the scope of the Royal Commission report.

During documentation of deliberations one of the facilitators explicitly asked jurors to clarify their ownership of what was being documented: “Is it yours jurors? Do you own it?” (Spark and Cannon 2016c, p185). This clarifying question was in the leadup to deliberations about how to include Aboriginal Australians more explicitly. This was mixed in with ethical deliberations about the whole process, including economic incentives and broader landholder rights.

“JUROR: We need to consult the Aboriginal people. I understand better today that there is different nation groups and I need to go and consult every nation group. I understand the need to be using an easy language and we need to do it in their own language, to use interpreters. That's my understanding, and also to consult the remote areas.

JUROR: Yes.

JUROR: Yes. Actually...

JUROR: Like an Aboriginal consultation headline, I think, also to consult the 10 remote areas, but also the language that we need to use to communicate to transfer this information needs to be easy, needs to be oral. That's my learning from today, and I also need to consult the remote areas.

JUROR: Can I just ask one question, that is probably dumb, but this nuclear waste dump for South Australia, is it an ethical question or an economic question? Why are we wanting it? Are we wanting it for ethics because somebody has to bury the waste where it's safest...

JUROR: Well, if you read the...

JUROR:...or are we wanting it...

JUROR: No.

JUROR:...to make money?

JUROR: You read the report, it's all about the...

JUROR: No. It is money.

JUROR: It's all about money.

JUROR: Okay.

JUROR: Yes. It states when it recommends it that it's the only economically viable prospect and it can generate a good - in the nuclear field.

MS WALKLEY: We now have two minutes. When I say "we", I mean you, jurors, have two minutes. Here is your report as it stands at the moment. The previous group's report, you having had a look and made some additions, would you all like to come and have a look and see how you feel about it, because at the end of this session it will be saved, it will be sent upstairs, apparently electronically, and then produced and turned around into something that you can have a look at after lunch.

JUROR: Just offer your best consultation should - I can't remember exactly the...

MS WALKLEY: Yes.

JUROR: That should also have, like, a subclause that especially whoever owns the land wherever it may end up, they should be first and foremost the - wherever the land is chosen, the people of the land should be happy before the next part of that consultation goes ahead.

MS WALKLEY: I'm thinking about what we know is in the Royal Commission report, which talks about a general social consent and then a consent if given for a site.

JUROR: Mm'hm.

MS WALKLEY: So there is information in the Royal Commission report about that, that there are two levels of potential consent or not. You could

refer to that section in the Royal Commission report, or the words we could put here are about both the state and the site, or what are the words that would work best there, jurors?

JUROR: Traditional owners or rightful owners or...

JUROR: Landowners.

JUROR: Landowners in general.

MS WALKLEY: That would cover...

JUROR: Traditional and/or - I don't know.

JUROR: Or non-traditional landowners.

JUROR: Traditional or non-traditional landowners.” (Spark and Cannon 2016c, p187-189).

This large excerpt from deliberations is included unabridged to demonstrate the pace at which deliberations happened and how they were shaped by organisational constraints. This extract was followed by discussion of the timing of consultations with landowners. Uncertainty about whether the outcomes of the deliberative process belonged to the jurors, as well as jurors' emphasis that other South Australians needed to play roles in the decisionmaking process, indicated their ownership was not strong. They were concerned about ownership of the outcome by specific interests, such as landowners, rather than seeing their role as a randomly sampled public as able to represent a public decision.

The dialogue above indicates aspects of organisational power in the process. The juror prefaced their question about ethics but saying it was “probably dumb”. This reflects discussion earlier in this thesis about what is considered rational and reasonable

argument, such as Habermas's (1984) communicative action. There was clearly a lack of consensus among the jurors about the underlying reasoning for a nuclear waste storage facility in South Australia, evidenced in this discussion on the third day of deliberations. This ethics and values discussion among jurors was interrupted by a facilitator reminding them they had only 2 minutes left. This indicates that despite the fact that the citizens' jury deliberations happened over two weekends rather than a single evening, as the first and second case studies did, participants' likewise may not have had as much time for deliberations as they would like. Nonetheless jurors revisited the issue of traditional landowners in these final two minutes, particularly about site-level consent as well as state-level consent. Participants in the jury clearly did not feel ownership of the decision about whether a nuclear waste storage facility should be built in South Australia, evidenced in their emphasis on landowners' first and foremost consent.

Statewide town hall meetings were the next stage of deliberations following this first Nuclear Citizens' Jury. These meetings and the jury processes were public in different ways. The citizens' jury process was public in that they were livestreamed and transcripts were publicly accessible. The town hall meetings were public in the sense that anyone in the geographical area in which the meetings happened could participate. However neither process had public ownership, given they were clearly organised by the Government of South Australia, with the citizen's juries facilitated by democracyCo, who were in control of the timing of the process and how outcomes were presented.

Discussion

Powell and Colin (2008) aimed for co-production and co-design in deliberative processes, while arguing that top-down processes might be unavoidable. The case studies presented suggest that while aiming for co-production and co-design can help mitigate the potential for systematically distorted communication and other power imbalances, established organisational frames remain strong. Case study two was more open than case study one, in the sense that the second case study addressed an open question whereas the first involved prioritising between three options. Case study three was specifically organised around the outcomes of an earlier Royal Commission, in which participants had no involvement. They called on expert witnesses who had given evidence to the Royal Commission, demonstrating linkages between multiple forums (Young 2006; Hayward 2008). However the top-down nature of this process was evidenced by the Royal Commission findings shaping public deliberations.

More open questions do not necessarily lead to fairer deliberations, given power imbalances and struggles in communicative engagement. This was evidenced in the second case study, when a group spokesperson said that a scientist had influenced their small-group discussions. Experts contributed to small-group discussions, confounding understanding of how their large-group presentations contributed to decisionmaking. The spokesperson was in a greater position of power than other group members, given they were speaking on behalf of the group in relaying the outcomes of small-group discussions back to the larger group. They used that power to indicate to the larger group that a scientist had distorted their communicative processes, which meant their outcomes were not as policy-focused as other groups had been. The group spokesperson's disclosure that a scientist had influenced their small-group discussion is

an example of the value of transparency in practice. This disclosure informed analysis of the case study, indicating power inequities.

What deliberations are about is important for considering the tradeoff between public and organisational ownership. Delgado et al. (2011, p834) argued that “organisers inevitably impose frames and meanings on to participants, which closes down possible alternative framings and opportunities to question fundamental issues”. If an issue can be geographically placed, as is common in natural resource management and was revealed as important in the first case study, then organisational ownership can be stronger as there is more likely an organisation that can be accountable for outcomes. This is evidenced in the third case study. In contrast, transboundary topics such as synthetic biology present challenges for organisational ownership, given there is little organisational control over their potential applications. The Nuclear Citizens’ Jury was focused specifically in South Australia, however deliberations remained transboundary, evidenced in participants emphasising that landowners’ consent should be first and foremost. Organisational ownership dominated the third case study, in which deliberations were clearly limited by the frames of the Royal Commission.

However such topics may also be out of the control of governments and regulatory agencies. Organisational ownership can relate to underlying systemic and legal norms that are part of unquestioned epistemological and cultural assumptions. This organisational control is public, in the sense that anyone can see it, but hidden, in the sense that only those looking for it may notice. In contrast, ownership can deliberately be out of the public sphere, in cases such as synthetic biology research funded by private or military interests. In such cases, there is no opportunity for public ownership, as organisational ownership is explicitly those with access to knowledge.

Wynne (2007) discussed invited and uninvited forms of participation; all three case studies presented were forms of invited participation. However uninvited participation has organisational norms too. Wehling (2012) argued that “uninvited” civil society organisations such as patient associations and environmental and consumer organisations had more impact on nanotechnology than invited forms of deliberative public engagement with science. Forums organised by such organisations are typically open access, rather than invited deliberations that involved specific recruitment. However they are rarely anarchic - even protests have organisational norms (Bennett et al. 2014). Social movements bring together diverse actors in organising processes (Haug 2013). Claiming public ownership of outcomes of a deliberative public engagement with science process is problematic in the same way any civil society group claims to be owned or controlled by the public. Issues of representation and inclusion discussed in the last chapter remain, raising issues of legitimacy and accountability.

This chapter has argued for understanding public ownership or organisational ownership as tradeoffs in framing deliberative public engagement with science. While processes are often justified as about giving power to people, in reality they are methods of co-production. Dietz (2013) included a list of criteria in research about bringing values and deliberation to science communication. The first set of criteria were for agencies to implement, reflecting the reality of organisational control in the design of deliberative processes.

Given the dominance of organisational ownership in deliberative public engagement with science, this thesis accepts organisational ownership as default. Claiming public ownership or trying to engineer it during deliberations could be seen as manipulation. So ways to support public expression in process and transparency in plans for change

from deliberations are more aligned with criteria for good deliberative public engagement than claims of public control.

Contrasting democracy and technocracy is a way of exploring organisational frames in science and technology policy. Ownership differs depending on the topic - for example in natural resource management ownership can be spatially constructed, whereas in biosciences functional boundaries may be more easily constructed. In the first case study about agricultural science research, participants decided between three research proposals. The norms embedded in this decisionmaking process were not under consideration, reflecting greater organisational than public ownership.

The second case study was a more open deliberative process about priorities for synthetic biology, however this did not necessarily improve public ownership of the outcomes. Results suggest that scientists' participation in small-group discussions systemically distorted a group's communication. A participant's openness in expressing this during the form indicates a degree of public power. Rather than being an example of strong public ownership, however, case study two is better described as an example of weak organisational ownership. No-one involved in organising the process was in a position to take forward recommendations that emerged. The transboundary nature of the topic made it difficult to establish any agency or authority who could be specifically responsible. It had greater public ownership relative to the others, partly related to the open framing of deliberations, but also related to the lack of organisational ownership.

Case study three was an example of the primacy of organisation argued by Bogner (2012 p519). Framing deliberations around the outcomes of the Royal Commission marginalised alternatives frames and ethical questions, such as whether alternative renewable energy options were a better investment strategy than nuclear waste storage.

Public ownership may be impossible to achieve from invited participation projects, however efforts to mitigate imbalances in power can improve deliberative democracy.

How participants communicate information is a way that power can be transferred in processes with more open framings. How information is presented influences understanding. For example in case study two, the order in which participants articulated their priorities shaped in what order and form they appeared in a list of priorities for all participants to vote on. Live transcription of these onto a screen was good for transparency but may not have supported fair deliberations, given the potential impact of order on voting.

“individuals typically resort to simplifying strategies such as lexicographic choice processes, whereby alternatives are ranked in terms of a single, most important dimension. At least initially, the favoured context is likely to be one that has been made most salient, for example by recent media reports.”
(Gregory 2002, p469).

In discussing value tradeoffs in environmental decisionmaking, Gregory said facilitators should enhance the salience of less favoured options and ensure attention is given to “less familiar dimensions of the problem” (ibid). While encouraging expression of diverse perspectives is good facilitation, there are risks that deliberately attempting to raise the salience of less favoured options may be manipulation. Supporting public ownership through transparent reproduction of deliberations does not necessarily improve outcomes, if those outcomes are then unable to be actioned because they lack organisational relevance. This will be discussed further in the next chapter.

Chapter Six: Upstream versus actionable outcomes

Introduction

The third and final tradeoff presented in this thesis is between upstream and actionable outcomes. Can deliberative public engagement with science be both upstream and actionable? In addressing this question, this chapter reviews the concept of upstream engagement and looks at outcomes from case studies in deliberative public engagement with science, with a focus on action. As with the other tradeoffs presented earlier, both upstream and actionable outcomes are ideals in literature about public engagement with science. However in planning a deliberative process they are better considered a tradeoff. Outcomes that are about some decision or binding commitment to policy change differ from outcomes that are about imagining futures through collaborative learning or building mutual understandings on a technical or emerging issue in which uncertainty is high.

Upstream engagement is typified by higher levels of uncertainty, which can promote open thinking but may make action beyond thoughts difficult. Deliberations focused on action tend to be further downstream in a planning, research or development process, when there is greater certainty. However actions at this later stage may impede those from earlier processes. Wilsdon and Willis (2004, p56) argued that taking public engagement upstream requires a mix of formal and informal methods “to democratise science and infuse it with new forms of public knowledge”. To justify time and effort invested in upstream engagement, meaningful outcomes are important.

Advocating for upstream engagement

The term upstream engagement refers to public deliberations during development phases of research, as opposed to downstream phases such as testing market acceptance. As discussed in previous chapters, Wilsdon and Willis (2004) argued that public engagement needs to move upstream, while analysing political discussions and documents in the UK referring to upstream engagement in emerging debates about nanotechnology. They argued that upstream referred to debate happening in science and technology development processes, as opposed to downstream “where technologies are waiting to be exploited but may be held back by public skepticism brought about through poor engagement and dialogue” (ibid, p19).

Upstream engagement is similar to the concept of anticipatory governance, a framing that emphasises co-production and collective imagination of people involved in deliberations (Barben et al. 2008, p992). A review of case studies in anticipatory governance regarding climate change argued it was an appropriate framework for issues featuring complexity, uncertainty, and distant planning horizons (Quay 2010, p496). Nanotechnology researchers have used the anticipatory governance framework (Barben et al. 2008; Karinen and Guston 2009). While upstream engagement typically refers to the stage of technology development itself, anticipatory governance refers to the sociopolitical context of technology development.

The stream metaphor implies a linear process of development. This has been critiqued, for example applied research can lead to basic research; both may be influenced by societal changes (Fisher et al. 2006, p490). The term midstream engagement has been introduced to describe incremental changes resulting from “practitioners’ changing cognitive interactions with their social and ethical contexts” (Fisher and Schuurbijs

2013, p98). This idea of midstream engagement is nonetheless framed within the linear model of upstream and downstream engagement it critiques. While research can and should be iterative, that some technologies did not exist once and now do is evident. So upstream engagement as a concept has value for considering whether engagement is happening before a technology is developed, or when it is already able to be used.

Where engagement happens in the research and development process has implications for what type of engagement is appropriate. Upstream engagement should not be about building consensus around options, but “mechanisms for expressing, identifying, and rethinking modes of governance” (Nisbet and Scheufele 2009, p1770). These mechanisms involve open questions rather than choosing between pre-established options. For example, the first case study asked participants to vote between three predefined options. In contrast, the second case study asked participants to choose their priorities for synthetic biology policy. Thus the design of the second case study is a better mechanism for upstream engagement. Upstream engagement also has implications for participation. Rather than focusing on predefined stakeholders, upstream engagement involves the “widest possible range of people who might be interested or affected, to help shape the trajectory of innovation and, where possible, to keep them open to alternative pathways” (Marris and Rose 2010, p1). While who is included within this range of people has been critiqued earlier in this thesis, ideals of upstream engagement are open to critique.

Challenges for upstream engagement

The main reason that the concept of upstream engagement has been critiqued is for impracticality. Tait (2009) discussed challenges in upstream engagement in the governance of science, dividing them into two categories: problems with prediction and

problems with stakeholder engagement. Prediction problems included the impossibility of knowing what outcomes will come from funding scientific research, and what risks will come from future developments. She noted that long-range technology development predictions are often wrong and argued that given innovation is often multidisciplinary, innovations might be blocked through outcomes of other engagement initiatives.

Tait argued there were seven problems with stakeholder engagement, summarised as follows:

- 1) Groupthink - participants being swayed by strong opinions.
- 2) Issue framing - fictitious framings given our ignorance of the future.
- 3) Recruitment bias - those who want to participate already have an agenda.
- 4) Conflict - where views are already polarised, engagement may increase conflict.
- 5) Engagement focus - topics such as nanotechnology are too multifaceted for meaningful engagement.
- 6) Engagement fatigue - insufficient time and resources for people to engage on every relevant issue.
- 7) Labile public opinion - people's opinions might change (ibid, pS19).

Elements of this list are examples of how the same issue can be approached through diverse frames. As discussed in earlier chapters, the seventh problem listed by Tait of changing perspectives may be conversely framed as a benefit in deliberative democracy theory. Listing issue framing as a problem is in itself a value judgement, given the inevitability of framing in decisionmaking (Tversky and Kahneman 1985) whether engagement is upstream or downstream. Whereas negative connotations with conflict

and engagement fatigue are clearer criticisms, Tait's use of issue framing on a list of negatives suggests framing bias itself.

Given she was arguing for freedom of research, Tait (2009, pS21) likewise argued for freedom to deliberate upstream, but called for the development of 'rules for engagement' to set standards for evidence brought to discussions. Criteria for deliberative engagement discussed in earlier chapters could be considered such rules, which address other problems listed by Tait. Recruitment bias was discussed in considering inclusion versus representation. Addressing power in process seeks to avoid groupthink, as discussed in the previous chapter. Problems of conflict, engagement focus and fatigue remain.

Tait argued that engagement may increase conflict, but evidence for this claim is scarce. A review of empirical literature about public engagement found no evidence to support this (Carpini et al. 2004). Tait did not define conflict in listing it as a problem with upstream engagement. There are conflicts of ideas (Macnaghten et al. 2005); deliberative, nonviolent conflict of ideas should be encouraged in democracy. Certainly upstream engagement generates further discussion and debate about issues; this is valuable for decentred deliberative democracy.

There is evidence that science communication can contribute to polarisation, particularly regarding climate change (Hart and Nisbet 2011). However research suggests this polarisation is more cultural than related to deliberative public engagement with science processes (Kahan et al. 2012). Hamlett and Cobb (2006) found weak support for the polarisation hypothesis in deliberative processes about nanotechnology. They argued deliberations can be structured in ways that mitigate potential decisionmaking problems and concluded by challenging assumptions that opinion

change consistent with polarisation comes from undesirable decisionmaking qualities. They argued polarisation related to two variables of deliberations: facilitation and the argument pool. The importance of the argument pool is related to the importance of discursive representation, discussed in Chapter Four. Deliberative democracy involves presentation of diverse discourses and perspectives that can lead to cognitive conflict, which has been positively associated with learning (Limón 2001). Thus rather than being framed as a problem, conflict can be framed as a positive aspect of upstream engagement, depending on the meaning of conflict.

Engagement focus and fatigue are related. Tait's statement that topics such as nanotechnology are too multifaceted for meaningful engagement invite the response that they should be broken down into issues capable of being meaningfully discussed. For example, different STEP engagement events were focused around different emerging technologies and scenarios. However, eliminating the problem of engagement focus would amplify that of engagement fatigue, if each facet of a topic were broken down into a separate engagement process. Chilvers (2008b, p3004) argued that public engagement experts were an emergent epistemic community who could reduce consultation fatigue through better collaboration.

Fatigue can come from engagement events that push to generate a consensus outcome despite diverse perspectives (Horst and Irwin 2010). This is related to spheres of agency in deliberative public engagement (Wibeck 2014); as discussed in the previous chapter, limited agency can frustrate participants and make them feel less predisposed to future engagement. Nanotechnology engagement in Australia has faced such critiques (Lyons and Whelan 2010). Addressing engagement fatigue by improving engagement focus is

only effective if the narrowed topic of focus remains meaningful enough to merit deliberations.

Many of Tait's (2009) problems with upstream engagement were concerned with whether engagement would stop action in research innovation and technological application. This leads to discussion of actionable outcomes from deliberative public engagement with science.

What are actionable outcomes?

Actionable outcomes are those that are action themselves or facilitate action. The ability to act is important. Delgado et al. (2011, p826) argued that public engagement is “coming of age” in STS, evolving beyond descriptive work to “developing practically oriented strategies for tackling the challenges of the science/policy interface”. Likewise a comparative appraisal of sustainability science projects emphasised the importance of generating actionable knowledge, arguing that descriptive–analytical knowledge production was less useful, though still predominant in research (Wiek et al. 2012, p7). Knowledge production can clearly be a valuable outcome, but what kind of knowledge indicates actionable outcomes?

Lezaun and Soneryd (2007, p288) identified three types of outcomes: firstly, affective changes in participants, secondly, documents and written accounts, thirdly, “the effects of the consultation on those who did not participate in it”, including influence on government policy and strategies of interest groups. Affect and influence are themselves actions; documents and written accounts may be an output documenting these changes. More pessimistically, documents may be recommendations or conclusions that never generate further action. If an outcome from a process is a list of recommendations, but

no-one with ownership of these recommendations has the capacity to act on them, inaction may ensue. If no participants in a deliberative process have the ability to act on outcomes, the risk of inaction is high.

Outcomes from the first case study

The first case study was designed as a pilot project to see whether the public could make consistent decisions about research funding, given challenges with the current system of funding discussed in Chapter Two. It was not a deliberation about whether the public should be involved in decisionmaking about science funding; rather it was a performative process to see what public participation in decisionmaking about science funding could look like. It was not upstream; it was collaborative action designed to find an outcome about whether public deliberations about science funding decisions might work. The framing of the project influenced the outcome, as it inevitably does. A consistent outcome emerged across three iterations of deliberations.

The outcome indicated that participants preferred to fund research about improving the salinity tolerance of Australian crops than research about nitrogen use efficiency or beta-glucan content. For this case study to be upstream engagement, it could have questioned whether plant genomics research to improve crops for Australian conditions should happen. There are a range of further upstream premises implied in that question. Indeed, more upstream questions about the ethics of plant science (Tester and Langridge 2010) and its ownership in Australia (Kingwell 2005) are in the public sphere. Wynne (2007) argued considering political and economic conditions was important for meaningful STS work. The research proposals were in an environment of scarce public sector funding and increasing pressure on universities to commercialise (Agius et al. 2006, p127). However public funding remains important, so the deliberations were

based on the assumption that the public have a right to participate in allocating public funding. The case study did not question whether the public should be involved in science funding decisions. It was based on the hypothesis that the public could make consistent decisions about prioritising research proposals and enact a consistent outcome.

The applied nature of the research proposals under deliberation allowed for a more actionable outcome - funding one of three research proposals. The location of benefits was considered important by participants, related to the applied nature of the research. For example, although crops with greater salinity tolerance have applications beyond Australia, discussions were oriented around Australia's southern wheat growing regions:

“It was a very difficult decision. I thought that all three were worthy of the funding. What swayed it was the immediate possibility of application to Australia's problems with salinity, especially in the Murray Darling Basin.”

Clear potential applications were used as a rationale for decisionmaking, which can be contrasted with the uncertainty of potential applications in upstream phases of research and development.

“The potential outcome is quantified. Research is well advanced (apparently). Rationale was well explained. Research purpose was clear.”

“Producing a condensed presentation forces one to clearly identify the critical part of a proposal leading to a clear choice.”

“Clear presentation, speaker seemed very comfortable with his proposal - very confident. Topic was a bit easier to understand and relevant to Australia in particular.”

“Relevance to Australia. Very comprehensive. Obvious applications.”

Participants focused their reasoning on the actual potentials of research in specific contexts, which meant deliberations were focused and the locations of benefits emerged as a consideration.

Participating in a research study to pilot deliberations about science funding is less impactful than if participants' deliberations about science funding actually resulted in research funding. A more actionable outcome would be if the process had actually resulted in research funding. The possibility of the idea is indicated in the emergence of crowdfunding in science, evidenced in medicine (Siva 2014) and ecology (Wheat et al. 2013). While actual research funding was beyond the scope of the pilot project, it generated collaborative learning among participants through their performative deliberations about it. Outcomes during deliberations, such as gaining new information and learning about new perspectives, were actions in process. People reorganised their thoughts about the research topics and the potential of public participation in funding decisions together, through deliberations.

Subsequent to this event, staff including scientists at the genomics centre contributed to further deliberative events, suggesting that some organisational change in terms of public engagement methods was an outcome. So while there were a range of outcomes, the aim of genuine public participation in research funding decisions was not actualised. The project did not involve people who had the ability to drive forward actual research funding decisions, so action potential was limited.

Outcomes from the second case study

The second case study was an example of upstream engagement. Its outcome was the generation of questions more than answers. The list of priorities created from

participants' deliberations was difficult to action. There were some clear outcomes, such as the finding that people did not want industry to make decisions about synthetic biology policy. However following deliberations uncertainty remained about who should be the decisionmakers. This high degree of uncertainty indicated an upstream engagement process.

The highest priority issue about who should be the primary decisionmakers about synthetic biology policy was a question with no easy answer; nor was any logical next step for action clear. Voting about who should be the primary decisionmakers during the forum did suggest consensus about who should not be in control. Throughout the forum, industry received no votes. Public servants and NGOs including charities received few. Scientists, elected officials and publics were the preferred decisionmakers at the start of the forum. In the final vote, more people had confidence in their voting and more people voted that elected officials and scientists should be the decisionmakers. However there was no consensus and several participants remained unsure.

The categories for decisionmakers could have been improved. These categories were adapted from an earlier UK study about research funding decisions (Rowe et al. 2010 p233). Adaptation was necessary, for example the EU was omitted as irrelevant in the Australian governance context. For future research, publics could be better differentiated from NGOs; the challenges of this were discussed in the previous chapter. It would be useful to separate publicly-funded scientists and industry-funded scientists, given that participants were unanimous in not wanting industry to make decisions about synthetic biology policy. However distinguishing between publicly-funded and industry-funded scientists is also problematic, partly because of the intertwined nature of institutions. Concerns about conflicts of interest in science are embedded in the peer

review system (Roy 1985, p74) and go beyond financial interests (Bekelman et al. 2003, 454). These difficulties with categorising decisionmaking contributed to the lack of a clear outcome from the forum.

Blumenthal (1992) detailed the risks of industry funding in life sciences, including increased secrecy in academic environments and damage to public support, as well as benefits. Demeritt (2000, p324) critiqued the “triple helix of intertwined university-state-industry relations”, noting transfers of knowledge from the public sector to private industry. Given the second and third most pressing issues were ethical frameworks for control followed by transparency, such risks and critiques reflect deliberations among participants.

Secrecy about commercial or military synthetic biology research can be contrasted with publicly available synthetic biology research into diseases, such as malaria and diabetes (Weber and Fussenegger 2012). However even with publicly available knowledge, synthetic biology is too far upstream as a technology for certainty in decisionmaking and governance. A participant expressed these uncertainties during the forum:

“...there was a little bit of talk about unknown unknowns, known unknowns and what sort of research has there be done in the known/unknowns, unknown/unknowns, because to say there are unknown/unknowns seems unusual given the fact that were examples about how they can be syntho-biotechnology to be done to assist with malaria. So there must be some sort of research into the known/unknown and unknown/unknowns.”

Uncertainty comes not only from information that exists in private spheres but not the public sphere, but also from a lack of information given diverse possible futures in upstream issues.

Public deliberations about synthetic biology reported in case study two preceded a flurry of publicly reported activities using methods of more traditional expert stakeholder engagement in Australia the following March. The Australian Defence Science Institute and Defence Science and Technology Organisation (DSTO) hosted a one day workshop on synthetic biology applications on 27 March 2012 at the University of Melbourne. This involved discussion among defence scientists and researchers from university and industry (Defence Science Institute 2012). In the same month, the Department of Industry, Innovation, Science, Research and Tertiary Education (DIISRTE) in partnership with the OECD hosted an invitation-only forum on synthetic biology, which was accompanied by a Scoping Workshop on Synthetic Biology Futures in Australia, both in Sydney (Hartz-Karp and Russell 2012). The outcomes of the latter invitation-only deliberations were reported under three themes, namely “convergent and open”, “socially responsible and responsive” and “life as a raw material”. In contrast to public deliberative methods used in case studies two and three for which primary data in the form of transcripts are available, there are no public records of these deliberations.

There was no indication in reports of the 2012 activities that they were in any way influenced by, or even cognisant of, public deliberations the year prior. However the 2011 events were supported by the same government engagement program as the 2012 scoping workshop, indicating that at least some organisers were familiar with prior deliberations. Given that the 2012 scoping workshop report covered themes of openness and social responsiveness, it may seem surprising that there was no mention of prior public engagement, nor any transcript of its deliberations. However it is less surprising in the context of research suggesting that governmental science risk assessments and

policy reasoning surreptitiously include inputs that are not explicitly or publicly reported (Livermore and Revesz 2014).

Learning from past mistakes and using information other areas was a way to address uncertainty given the upstream nature of synthetic biology suggested by a participant:

“I find myself thinking back, this has happened before, we’ve explored new technologies and we’ve got our fingers burnt and then we’ve learnt how to harness those technologies but we still occasionally have sparks that ignite parks - if I can use the fire analogy. Growing up it takes a while ’til you learn that point, you know lighting the candles on a birthday cake if you start on the other side you’re not going to burn your hand as you get closer but there’s an educational component to that. Where are we on the scale? Because around fire we have enormous amount of knowledge as a species, around this we have very little knowledge – can you share some of the examples of things that have gone wrong, some of the near misses, some of the things that keep you guys awake at night because I think it’s only when you actually understand the difference between burning a can of petrol and climate change there’s a scale to these things that we need to get into place in order to assess the quality of those benefits against them.”

A scientist responded to this by referring to learnings from public backlash against research into genetic modification last century.

“...we were all sort of fired up about this wonderful stuff that we were doing and really excited about how we were going to make food for the world and we were going to save people in developing countries which were called Third World countries back then but you know it’s all PC nowadays and we were really passionate about the science that we were doing and then people were unhappy about it and we were a bit sort of miffed that they weren’t excited about it too. And we kind of went on and did it public they’ll get over it, they’ll move and they’ll understand but they didn’t. And we learned from that we did actually learn from that that was really an entirely wrong approach, that we have to be accountable for the research that we’re doing and as we said, it’s public funding that’s been spent on the work that we’re

doing, and we have to be able to explain why and how we're doing it and the public has to be happy with that. And so what I find really amazing about this debate that we're having tonight, that we've been having all week now at various different locations is that here we are addressing an issue in Australia, the science is barely getting started yet but we're already dealing with the legal, ethical aspects of it that are so very important."

The scientist argued that synthetic biology science is barely getting started, yet ethical and legal aspects were being debated during this upstream research phase. This was contrasted with the development of genetic modification techniques last century, when public engagement was left until downstream in research development timelines.

In contrast to the first case study, the second case study was an example of upstream engagement. There were high levels of uncertainty before and after deliberations.

Voting on categories of who might be decisionmakers about synthetic biology likely contributed to this being the issue most participants considered highest priority.

However that questions of control and transparency emerged as the next priorities reinforced the importance of questioning who had power. The second case study was further upstream so less grounded in particular applications. Though participants were polled on three particular applications of synthetic biology during the night, this was attitudinal voting rather than voting for making a decision, as in the first case study.

The significance of location in the process was another contrast between the two case studies. The location of these deliberations was not significant, evidenced in similar findings between this case study and a European project on societal aspects of synthetic biology (Schmidt et al. 2008). However replication is valuable in the generation of knowledge and for promoting decentred deliberative democracy. The outcomes have

value in supporting the findings of the European project with data from another society on another continent.

The second case study, funded through NETS-PACE, can be contextualised alongside instances of upstream engagement in the STEP program. The STEP program generated new shared understandings and a framework that, through being enacted, became arguably the biggest outcome of the program. An evaluation of a STEP workshop about the social implications of enabling technology found that discussion “did open up thinking about the topic, but some found it too broad, and this may make it difficult for this thinking to translate into changes in practice” (DeHaan 2012, p4). This suggests that the workshop was an example of upstream engagement, where a lack of applied focus limits actionable outcomes but opens up discussions about possible futures.

An independent review of the overall NETS-PACE program of which STEP became part (Gascoigne and Cronin 2012) generated further deliberations with a range of stakeholders in and beyond the process (Cronin 2012). The second case study, though funded through the NETS-PACE program, was not one of the projects evaluated in the independent review. The Office of the Australian Information Commissioner (OAIC) was one organisation whose response to the review of the NETS-PACE program was public. The OAIC said that the program could “benefit from greater openness and transparency” (Dobinson 2012, p3). This reflects the question of why transcripts from later 2012 deliberations on the synthetic biology, one theme of which was “convergent and open” (Hartz-Karp and Russell 2012), were not made public.

Ongoing deliberations, some of which were public, indicated a high level of engagement, at least within the public engagement practitioners’ community of practice (Wenger 1998) developed through the NETS-PACE project. Indeed, in 2011 the STEP

framework won an award from IAP2, indicating the support of this community (Russell 2013, p570). This indicates impact on public engagement with science in Australia, through collaborative learning among those involved in the project. The impact however was not on science policy, given that deliberations may have been too far upstream for action. The impact came from participants enacting deliberations and learning from the processes.

In reflecting on the STEP process Russell (2014, p8) called for ‘best we can’ practice “to maximise the long term sustainability and impact of deliberative democratic practice”, focusing on incremental progress and framing projects in ways that maintain support from those in power” (ibid, p9). This is more akin to midstream engagement, focused on incremental changes from people’s cognitive interactions (Fisher and Schuurbiers 2013, p98). Wynne (2007) argued that meaningful work in STS needed understanding of political economic dimensions of today’s techno-sciences. Defence funding of synthetic biology research in Australia following 2012 public deliberations may have reduced communication in the public sphere. Framing projects in ways aligned with those in power, such as the need to research synthetic biology in society for national security reasons, may be incompatible with framings about empowerment and deliberative democracy.

Russell (2014, p8) argued that maintaining support from those in power was important for impact of deliberative democratic practice. There was no public support for industry control over who makes decisions about synthetic biology policy in Australia during public voting in 2012. The best that deliberative practitioners can achieve depends on context; in the context of limited public information given industry secrecy, the potential for deliberations to have impact is low. Futures of humanitarian DIY biology

to empower people (Golinelli and Ruivenkamp 2015) to address problems neglected by industry may indeed be fictitious, as Tait (2009) critiqued.

Alternatively, synthetic biology may be moving too fast for people to absorb information so they can arrive at mutual understandings. Transcripts from deliberations in the second case study are only now being published as the Appendix in this thesis. Synthesising literature for review in this thesis was challenged by the emergence of new reports between iterations of drafts. Synthetic biology may lack “bundles of topically specified public opinions” in the public sphere (Habermas 1989, p360). Young (2002, p170) argued the public sphere was a continuous struggle; this thesis is part of the struggle for public deliberative public engagement with science. Writing this thesis was a communicative action, in being read it may become an actionable outcome from the second case study.

Outcomes from the third case study

The third case study was clearly an example of upstream engagement. Deliberations featured discussion about complexity, uncertainty and the distant planning horizons of contemplating the storage of nuclear waste. The challenges of uncertainty in the third case study were evidenced in jurors’ interactions interpreting information presented:

“JUROR: Unmeasurable?

JUROR: Unknown.

JUROR: Unknown.

JUROR: Unknown without further, what’s the word?

JUROR: Research?

JUROR: Research or, yes.

JUROR: I think it's pretty clear that there's been quite a lot of research on it and the impacts are kind of negligible. Getting into the nuts and bolts of statistics is really hard." (Spark and Cannon 2016d, p224).

Nanotechnology researchers have noted that "unknown unknowns", cannot be reduced overnight" (Joly and Kaufmann 2008, p226), indicating the challenge of generating actionable outcomes from deliberations featuring such uncertainty. The Nuclear Citizens' Jury clearly stated in its report the need for further deliberations with more South Australians and further information, some of which needed legislative change to gather.

Upstream engagement is characterised by uncertainty, which can breed inaction. Upstream engagement invites future participation for legitimacy, seen for example in the Nuclear Citizens' Jury emphasising the need for continuing engagement and concern for future generations. The South Australian Premier Jay Weatherill, in addressing the Nuclear Citizens' Jury on its first morning, described how it was happening upstream of government action:

"What the entire Citizens' Jury and consultation process does is not to arrive at a decision, but to actually arrive at a decision about whether the government can make a decision." (Spark and Cannon 2016a, p6).

The outcomes of the deliberative process were further questions, to be considered by a further citizen's jury and town hall meetings throughout the state. This is challenging for transparency and accountability, as it is not clear given this diffusion of deliberations how the process of the first citizen's jury was actually contributing to decisionmaking.

While the report emerging from the Nuclear Citizens' Jury was designed to engage further citizens of South Australia, further actions of town hall meetings and a second citizens' jury were already planned before the first process finished. Thus they cannot be described as outcomes of the first. Certainly the report of the first citizens' jury can help to draw the attention of subsequent deliberators to certain aspects of the Royal Commission report, but if it were not for the first citizens' jury, later deliberations would have discussed findings of the report regardless. The outcome of the first citizens' jury, highlighting certain parts of the Royal Commission's findings as relevant, is not binding. Later deliberations among other groups of citizens may choose to focus on aspects of the Royal Commission report not deemed most important by the first jury. This jury process was clearly an example of upstream engagement.

Upstream engagement processes have been criticised for focusing too much on human imagination and too little on what will practically happen in future. Based on this logic, grounding the upstream deliberations of the Nuclear Citizens' Jury in the findings of the Royal Commission is a way to improve the efficiency of outcomes. Efficiency of outcomes was an area of consensus discussed in the introduction to this thesis (Smith and Rowe 2016, p61; adapted from Chilvers 2008a, p159). This ensured the relevance of the outcomes of the Nuclear Citizens' Jury to future deliberations and an ultimate policy decision about whether or not South Australia should be more involved in nuclear fuel cycles.

However this closed down alternative visions about alternative renewable energy sources, or full Aboriginal Australian control of decisionmaking about South Australia's outback. The fact that in 2016 citizens were deliberating about the results of Royal Commission into South Australia's role in nuclear fuel cycles is an outcome of

Australia's colonial history. While the process can be evaluated well from the perspective of efficiency, fair deliberations may be impossible given the historical context.

Discussion

Wilsdon and Willis (2004, p56) asked “can upstream engagement reshape not only the way that science relates to public decision-making, but also the very foundations of knowledge on which the scientific enterprise rests?” This ambitious question represents an optimistic view of upstream engagement and its potential for transformative change. However challenges to the foundations of knowledge on which science rests can also be framed negatively. Tait (2009, p521) argued that “the social science agenda within which upstream engagement is located can be seen as taking us deeper into a mire where we will have no solid evidence base for making decisions about scientific developments”. For those preferring solid evidence and certainty, outcomes from upstream engagement may be perceived as pure imagination with little actionable use. On the other hand, deliberations around a predefined set of outcomes ready to be actioned can perpetuate power imbalances and courses of action that already alienate publics whom public engagement with science seeks to include. The potential for organisational change can make upstream engagement appealing or threatening, depending on perception.

Participatory designs embody tacit assumptions about governance processes to which they can contribute and the roles of participants in them (Felt and Fochler 2008, p493). Designs that support actionable outcomes are focused on mobilisation and organisational change (Lezaun and Soneryd 2007). This organisation is not a disembodied institution, rather an assemblage of people participating in multiple

realities, some of which are organised within institutions, and some of which are simply the way people conduct themselves - the way things are. The way things are can change; how we organise our thoughts and ourselves can change when we see different perspectives and gain knowledge. Methods of co-production, participatory action research and collaborative learning generate outcomes in the process, rather than being recorded as recommendations for future action. Participatory design can support actions which themselves are outcomes.

Nanotechnology researchers discussed unknown unknowns, “featuring completely unforeseeable and unanticipated surprises, of form, scale, and probability of events”. (Randles 2008, p271). The second case study of synthetic biology deliberations featured unknown unknowns, given it is such an emerging discipline and there was little information available on real-world applications and their consequences, because few exist yet. The third case study of deliberations about nuclear waste storage had more characteristics of known unknowns - there was detailed information available from the Royal Commission, based on decades of experiences with nuclear globally. There are known risks that must be managed, but how to manage those risks is not only a matter of scientific fact, but includes matters for social deliberation.

Presenting upstream or actionable outcomes as a tradeoff is designed to support deliberative practitioners in deciding what type of deliberative method to use and to be realistic about what kind of outcomes are possible. Given lack of evidence for deliberative outcomes having impact on policy, designing a forum so that collaborative learning is valued as an outcome of the process itself can be a more realistic aim for evaluation than policy change.

Organisational change is more likely if participants in a process form part of that change. Deliberations aiming to influence an organisation should involve people who work within those organisational norms, so that outcomes are developed from mutual understandings of these norms and how they might be changed. This relates to the tradeoff presented in the previous chapter. Independence is a criteria appearing in different ways in different lists of criteria for good deliberative public engagement with science. While independent facilitation is consistently valued, whether lists suggest participants should be independent varies. If participants are all independent from an organisation that outcomes from deliberations are intended to impact, recommendations may be ignored or rejected as not actionable.

However, emphasis on actionable outcomes and ensuring the participation of organisational stakeholders may mean that alternative voices or visions to those embedded in organisational norms are not noticed. Even when they do feature during a deliberative process, they may not be included in outcomes, which are typically summaries or recommendations from deeper deliberations. Outcomes are not only resulting documents, but also affective changes from deliberations. Participants may have negative affective experiences if their contributions during a process are not valued in outcomes, undermining civic values of deliberative democracy. This can lead to frustration or fatigue.

This chapter has argued that a third tradeoff in deliberative public engagement with science is between upstream and actionable outcomes. The uncertain nature of upstream deliberations means that outcomes are more likely to be affective or knowledge changes among participants, rather than direct policy change or some binding decision. So in designing deliberations, practitioners should consider whether a process is intended to

generate a clear actionable outcome or collaborative learning and mutual understanding in conditions of uncertainty.

Considering whether deliberative public engagement with science can be both upstream and actionable invited exploration of the meaning of upstream engagement, as well as potential for action. Whether there is potential for actionable outcomes depends on whether participants in a process have power, particularly when outcomes are recommendations. This power relates to organisational change internally and externally. Collaborative learning from deliberative processes can generate affective changes in individuals' understanding and perceptions. Deliberative processes can also generate change in organisations, if participants have the power to create change at organisational levels.

Upstream engagement is characterised by uncertainty, which may breed inaction. Action-focused deliberations further downstream may be already framed too narrowly to support meaningful public engagement. Consultation fatigue is a risk of repeat deliberations through the research process, indicating why upstream engagement is a tradeoff against decision-oriented deliberations further downstream.

Co-production processes that are deliberative public engagement *with* science are preferable to deliberations *about* science. Deliberative public engagement with science is performative. Affect and influence are outcomes that are actions. It is through the performance of deliberative public engagement with science that new shared understandings are created and organisational change is possible. If actionable outcomes are generated in deliberations themselves, then actionable outcomes are compatible with upstream engagement. However discussing outcomes typically refers to looking at what happens afterwards, not what happens during a process. Thus upstream outcomes and

actionable outcomes are framed as tradeoffs in deliberative public engagement with science.

Trading off outcomes is risky as people may reject the frames through which comparisons are presented. For example, in the third case study, some participants wanted a frame in which alternative energy options to nuclear were considered, rejecting the frame of economic development being tied to the nuclear industry. Presenting tensions or lists of ideals is less risky, because it does not force people to question assumptions and prioritize values, as was discussed in the introduction of the last chapter. Prioritising upstream or actionable outcomes forces practitioners to consider their expectations about what might be the results of a process. Considering this is part of design and evaluation, important for transparency and accountability. This builds on the previous tradeoff about public or organisational ownership, arguing that organisational ownership is normal for invited methods of deliberative public engagement with science.

The subsequent chapter does not present a tradeoff but rather a way in which the three tradeoffs can inform understanding of the context of a deliberative process. Considering whether an issue is framed as transboundary or local is presented as the final analysis chapter, following this final tradeoff analysis of upstream versus actionable outcomes. These analyses are entangled; as Delgado et al. (2010) argued in discussing tensions, all facets of design are entangled. However upstream or actionable outcomes is more entangled with whether an issue is framed as transboundary or local than the other two tradeoffs. Whereas outcomes are associated with the end of a deliberative process, issue framing as local or transboundary is associated with the site of a deliberative process and the scope. The temporal site of a process indicates whether upstream or actionable

outcomes are more realistic goals. As will be discussed in the next chapter, upstream issues tend to suit transboundary issues because of higher degrees of uncertainty.

This uncertainty not only relates to whether deliberations are about an emerging technology, upstream in a technological development process. Uncertainty can also be about boundaries: temporal and spatial ones, as well as political and regulatory ones. In designing a deliberative process, being clear about what boundaries one is working within is valuable, particularly for considering what outcomes are achievable. This is not a tradeoff, it is a situational analysis. Various boundaries should be taken into account and on which scales deliberative outcomes could have impact indicate which might be more appropriate frames.

For example, synthetic biology is an upstream issue from the perspective of technology development. However difficulties actioning outcomes of the second case study related to discussing synthetic biology as a transboundary issue. Deliberations were framed so openly that all boundaries were up for debate. The boundary of Australia was an anchor for discussions, however participants discussed action in the United States repeatedly, given Australia's relative lack of research and development in synthetic biology.

Localising deliberations through focusing on a particular legislative boundary or a particular timescale that their priorities should be actioned in, would have yielded different outcomes. While these outcomes would have still been about an emerging technology, they might have been more actionable. Uncertainty about the technology and its outcomes could have been grounded with greater certainty about temporal or legislative boundaries.

Upstream in STS typically refers to early stages of a technology's development.

However in considering outcomes, other temporal boundaries are relevant, such as those

of governance and legislation. Geographical boundaries are also important, as greater certainty exists in more clearly demarcated areas. Situating deliberations about emerging technologies in clearly delineated boundaries supports more actionable outcomes. This is discussed in further detail in the next chapter.

Chapter Seven: Transboundary and local issue framings

Introduction

This chapter explores how whether an issue is framed as local or transboundary can shape tradeoff choices. The last three chapters presented tradeoffs in deliberative public engagement with science between representative or inclusive participation; public or organisational ownership; and upstream or actionable outcomes. In this chapter, the three tradeoffs are presented as a framework mapped onto local or transboundary issues.

Deliberations happen about a range of science and technology issues, which can be framed as either transboundary or local issues. Given the diversity of possible scales and frames, considering the boundaries of an issue in the design of a deliberative process is important. Boundaries need to be transparently communicated for accountability. What access to information participants have as a default base for deliberations depends on what boundaries are used. Likewise what information participants choose to share from their experiences or ask of experts in process is shaped by through what boundaries issues are framed.

‘Transboundary’ can be defined across different dimensions including time, politics and geography (Ansell et al. 2010, p196). Participants in all case studies in this thesis referred to geographical and temporal boundaries in communicative actions shaping mutual understandings. Some other boundaries were evident in certain cases, for example the need for legislative change was noted in case study three. Political boundaries emerged in deliberations of case study two, in which American regulations

and authorities were explicitly discussed. Given that there are multiple ways an issue can be transboundary, participatory inclusion depends on more than considering the geographical scale of an issue.

Inclusion in local decisionmaking

An issue is clearly being framed locally if everyone in a given location is included directly in decisionmaking. Clarifying whether an issue is framed as local or transboundary can be a question of whether it is physically or practically possible to include everyone in a deliberative process. Whether full inclusion is practical for deliberative public engagement with science involves considering whether everyone participating will have opportunities to express themselves and share communicative actions to arrive at mutual understandings.

Full inclusive participation may be called direct democracy (Matsusaka 2005).

Referenda, already an established part of Australian democracy, are an example of direct democracy in practice. However direct democracy may not be deliberative.

Referenda are direct democracy, but they are only deliberative democracy if all voters have opportunities to engage in deliberations to inform their voting beforehand. Full inclusion in deliberative public engagement with science involves scaling issues to levels in which all can choose to participate.

Decentred deliberations as an alternative to full inclusion

Given that several types of boundaries are relevant, full inclusion is challenging. There are few opportunities for inclusive decisionmaking in which everyone can meaningfully contribute. Even focusing deliberations on a sufficiently geographically small scale will only engage people at one specific point in time. Iterations of deliberations in the same

place at different timepoints may include different people. Different people participating means that mutual understandings may draw on different argument pools, some potentially with greater diversity in discursive representation than others. Young (2002, p46) argued for a decentred model of deliberative democracy, recognizing that “processes of communication that give normative and rational meaning to democracy occur as flows and exchanges” across distances and over time.

Particularly in emerging technologies, knowledge changes, so outcomes from deliberations two years ago may not reflect the perspectives of participants now.

Delaying decisions until certainty increases is risky, given potential consequences of inaction (Dietz 2013, p14082).

Hayward (2008, p79) argued that past injustices and future consequences mean local deliberative responses may be inadequate.

“many difficult environmental issues are decentered in space and time, involving multiple actors, jurisdictions, and institutions. The complex historical origins of these problems involve past injustices and have consequences that obligate future generations.”

She argued organisers of deliberations needed to give voice to local communities wanting to talk about transboundary issues, while simultaneously aiming for actionable outcomes. How different times are treated in decisionmaking is a value judgement and thus part of framing (Dietz 2013, p14082). Linking together local decentred deliberations is important so they can become part of larger movements for change over time.

Regional differences in transboundary issues

Differing perceptions of certainty mean that how deliberations are framed is subjective; transparency in defining boundaries is important given this subjectivity. For example, deliberations about genetic modification policy in the US have tended to be further downstream than Europe. People in the US have deliberated about products reaching the market, whereas Europeans have deliberated whether genetically modified foods should be allowed (Gaskell et al. 1999). A systematic review of public perceptions of genetically modified foods found that risk perceptions were greater in Europe than North America and Asia, while the reverse was true of benefit perceptions (Frewer et al. 2013). Transboundary deliberations about the ethics and risks of genetically modified foods differ from local deliberations about whether they should be used in practice.

Regional differences in perceptions of certainty reflect how differently the precautionary principle is applied in regulations internationally (Sheng et al. 2015). Upstream normative questions about whether or not research using genetic modification should happen differ from localised questions about community acceptance of genetically modified crops. Once crops have been developed, questions are localised in deliberations about whether they should be grown or consumed in a particular place.

Research has suggested that resolving contrasting EU and US framings through the World Trade Organization (WTO) might be more costly than working out new bilateral trade agreements (Punt and Wesseler 2016). Wynne's (2007) argument that political and economic norms should be considered in STS work demonstrates the relevance of considering norms about risk perceptions in planning deliberative methods. The inability of the WTO to resolve conflicts about trade in genetically modified foods indicates how local deliberations have value alongside transboundary ones.

Local framings

Focusing on local narratives for science and technologies helps to situate them in actionable decisionmaking. For example, deliberating about the potential uses of synthetic biology for remediating a particular waste site can give the transboundary issue local relevance. This framing inevitably shapes the process and thus outcomes, but it is because framing is inevitable that it should be explicit (Nisbet 2009). Local framings are related to stronger organisational ownership and more actionable outcomes.

Transboundary issues can seem overwhelming; focusing on local framings can alleviate this. For example, the transboundary issue of climate change can induce fearful emotions (O'Neill and Nicholson-Cole 2009, p15). Climate change is a transboundary issue spatially, in that it crosses geographical borders, as well as temporally, in that its effects are long-term; it also shares the common transboundary characteristic of uncertainty (Morton et al. 2011). Breaking the transboundary issue into ones suitable for local decisionmaking, such as for example whether seawalls should be raised in a city in response to rises in sea level (Shaw et al. 2009, p449), can allow a community to act.

However situating climate change in a given location and actionable decision can avoid people confronting the transboundary issue. The local frame precludes collaborative learning about the causes of climate change and how they might be addressed, instead focusing on downstream options for adaptation. As discussed in the last chapter, upstream deliberations can result in affective outcomes, such as changes in attitudes, as well as greater knowledge. However the affective change may frighten or overwhelm, as documented in climate change studies (O'Neill and Nicholson-Cole 2009), so

deliberations at this long-term and transboundary scale may disengage rather than engage participants.

Mapping tradeoffs onto transboundary and local frames

Wynne (2007) argued that STS scholars should take into account political and economic contexts of their work. This includes regional contexts as well as local ones, as argued above. Based on understandings of these contexts, practitioners of deliberative public engagement can make decisions about how to make choices about the three tradeoffs presented in this thesis. Figure 7.1 shows comparison of the tradeoffs based on local or transboundary issue frames.

Figure 7.1: Comparison of tradeoffs based on local or transboundary issue frames

Local:	Transboundary:
<div>inclusion / representation</div> <div>recruitment</div> <div>public / organizational</div> <div>ownership</div> <div>upstream / actionable</div> <div>outcomes</div>	<div>inclusion / representation</div> <div>recruitment</div> <div>public / organizational</div> <div>ownership</div> <div>upstream / actionable</div> <div>outcomes</div>

Under the local heading the three tradeoffs are listed, with inclusion, organisational and actionable circled. Under the transboundary heading the same tradeoffs are listed with representation, public and upstream circled. The three case studies will now be analysed based on this framework.

Case study one: Local matters

The first case study was focused on research funding in Australia and the Australian scale as a boundary for decisionmaking was further localised by participants in their decisionmaking. More participants made their decisions based on local frames than transboundary frames, though both were evident. Frames were evident in qualitative responses to an open-ended survey question about why they voted the way they did. Local frames were both spatial and temporal.

The importance of temporal location was evidenced in several participants explicitly mentioning ‘short-term’ in their decisionmaking, in contrast with a single participant who referred to ‘long-term’.

“Potential solution in the short term to a serious problem.”

“In the short term, I think salinity and crops is the most important issue that needs to be addressed.”

“Easy to understand. Relevant issue both locally and nationally. Has potential for short-term solution to a global problem.”

In the last quote, while the issue was identified as transboundary (however particularly impacting the Australian wheat belt), decisionmaking considered the immediacy of outcomes. Participants expressed their short-term framings through a variety of related words, including quickest, pressing and immediate.

“This I feel will get the quickest result in shortest time frame, for I feel most benefit for Australia.”

“The issues addressed appear to be much more pressing and relevant at this point.”

“In terms of the immediate impact of the proposal I thought no. 1 (A) could have the most impact. The global shortage of food along with a growing global population pose a serious threat and I believe this is a possible solution. I felt proposal no. 2 (B) and no. 3 (C) were also important but not to the same extent as no. 1.”

Responses about the immediate impact illustrates how certainty related to decisionmaking. Transboundary factors were identified, in the last response specifically global food security and population growth. So in the last response the issues considered were transboundary, but the deciding factor was which had the more temporally local outcome.

“I vote for A because I think that by addressing the immediate problem with salinity other benefits will follow and we can make other improvements from that point (hopefully!!).”

This participant also based their decision on the most immediate outcome, which they identified as a point that other improvements could follow from. This specific point is local, while future improvements following from that are transboundary, across different points in time and issues. Certainty of outcomes indicated decisionmaking at a local rather than transboundary scale. One participant explicitly stated that the three research proposals were equally as important, so they voted for the one most likely to have short-term outcomes, even if others could do better over time.

“Already getting results. Equally important to others. More likely to achieve research outcomes. Note, others could do even better over time but outcomes less certain?”

In contrast to the dominant short-term framing, only one person explicitly based their decision on a long-term frame:

“Ultimately it came down to environment and the benefit for that. The other two had benefits for humankind but I'm more concerned with the long term future of the planet.”

The presence of some long-term decisionmaking criteria within the dominant short-term frame is an example of diversity in the argument pool discussed in earlier chapters. Having diverse perspectives about priorities in decisionmaking improves discursive representation, which can have benefits for collaborative learning. If all participants felt the short-term frame was the most important decisionmaking criteria it may have indicated groupthink, as warned by Tait (200, pS19). Temporal location was an important factor in decisionmaking, with both short-term and long-term frames represented, but most participants stating that short-term outcomes were more important.

Local benefits were articulated by more participants than transboundary benefits, though whether local meant a specific river basin or state varied. In cases where transboundary outcomes were mentioned, local outcomes were often mentioned concurrently. Spatial location was evidenced in several participants mentioning Australia, or specific places like South Australia or the Murray Darling Basin.

“Salinity to me is the most important element to Australia and its food crops and hence income to our country.”

“Salinity is a very Australian problem.”

“Salinity of soil is a huge worldwide problem with particular problems in my backyard ie. South Australia. The proposal had immediate relevance.”

“It was a very difficult decision. I thought that all three were worthy of the funding. What swayed it was the immediate possibility of application to Australia's problems with salinity, especially in the Murray Darling Basin.”

Different scales are evident. Some people referred to Australia, some to the Murray Darling Basin. Someone clarified that they meant South Australia when referring to their backyard - their actual yard on a plot of land would have been a much smaller scale. What is consistent in these references is that people were basing their reasoning on benefits of research in an area they felt was relevant. This variance in scale is relevant to designing the boundaries of deliberative public engagement with science, because participants may arrive with diverse expectations of what local means. Thus being transparent about intended scales helps to establish shared mutual understandings.

Case study two: Transboundary synthetic biology

In contrast to the first case study, the location of the second case study may have been less relevant, evidenced in similar findings from a European project on societal aspects of synthetic biology (Schmidt et al. 2008). As well as sharing similar findings to a European study, the discussions in the second case study focused on transboundary issues. A transcript of the large-group deliberations was made from a recording of the event, then the content of what each speaker said was summarised for analysis. The entire transcript was also analysed for word frequency. The word “unknowns” appeared 11 times and “certainty” appeared 3 times, indicating that uncertainty was discussed in deliberations, reflecting a transboundary issue.

Discussion varied between objective scientific discussion and transboundary concerns. For example, the first question following the expert presentations was a scientific question about where the DNA used in synthetic biology comes from; the response about nucleotides and organic chemistry was likewise scientific. The next question referred to the transboundary nature of synthetic biology:

“we were discussing them on a national level how this might be controlled, and it seems to us that it’s much broader, this is international there are no boundaries, when you can order it over the internet, are we just wasting our time even discussing this here because can someone in some remote country do something with anything we might say or believe, matters?”

This launched a discussion about bioterrorism and biosecurity, which remained a theme, particularly regarding the United States. Australia was referred to only three times during the deliberations - the same number of times the city of Boston was mentioned. This was due to a story shared by one of the scientists about a lab researching Ebola in Boston that had a biosecurity containment incident. The United States was also mentioned in other parts of the deliberations about bioterrorism and biosecurity:

“...bioterrorism issue- presumably there’s this horrible dangerous organism that you could create using this technology - the Americans would have already discovered it.”

Alan: “I don’t know who is the most American - it’s you Desmond. Don’t you think it’s all to do with the State Department?”

Desmond “Well I don’t have an American accent. Sorry I’m not sure I understand the question so you’re saying are the Americans doing something to, to control bioterrorism or...”

Alan: “Create it I think is what you were saying?”

Rachel: “It was more like a comment wasn’t it that if I understood you, probably it’s quite likely the Americans have created these things and so probably quite likely they have the antidotes in a way Claudia was talking about?”

The United States was raised again in a discussion of unknown unknowns:

“There are people trying to research into unknown unknowns and I think that the strongest example of that at the moment is in the US where there is extremely active anti-bioterrorism research so there are some incredibly good people and very good labs racing like crazy to think up weird and wonderful ideas that the nutters out there might be thinking up themselves and finding ways to mitigate against that and every time you go through the airport in America you’re probably reminded of that, you’re constantly reminded...”

Interestingly, during deliberations bioterrorism researchers were contrasted with “nutters” (above) or “maniacs”:

“...we thought while obviously regulation’s important, you need to have a discussion about that to find the right balance. You obviously don’t want to have too much control but you don’t want to have no control so that the complete maniacs do damage.”

An expert scientists used “nutter” in the question and answer deliberations following their presentations, while a participant used “maniac” when relaying outcomes from their small-group discussion later. “Terrorist” was mentioned only one time in the last recorded deliberations of the evening:

“I think the reality is that the people who want to do this sort of thing aren’t unregulatable [*sic*] in any way so it’s not going to be the industry itself, Desmond and I and various other people who are doing it, that are going to be trying to create synthetic biology monsters, it’s going to be your bioterrorists that are well outside any kind of regulation that we can apply anyway.”

These unregulatable people, whether described as maniacs, nutters or terrorists, were framed differently to trained scientists working in labs who were involved in near misses. This is evidenced in the Boston lab story:

“...in labs we have protocols in place for containing potentially hazardous organisms and every now and then you do hear about near misses. So you know where I used to live in Boston, there was what is called a Biosafety Level 4 lab, which is very, very rare, most cities don’t have them. In Boston there is one which is in downtown Boston which is very unusual but you know those are the kinds of labs where they do work on Ebola they do work on sort of you know highly infectious agents, and yeah there was one year – it made it into the paper, they had a fire or something and then they had to close down the building and then one of the employees was working in a lab on level 4 just went home and you know that’s not supposed to happen. Right. So there are - there are complete protocols in place, people who work there have to train for a long time to work in those labs, and you know we do have some experience in containing organisms and making sure they don’t get out, you know out of the lab.”

This different framing of public participants gone bad or crazy, as opposed to people in organisational positions making mistakes, was questioned in Tocchetti and Aguiton’s (2015) questions about whether an FBI agent is like any other participant in a DIY biology meetup. Regulations are a type of boundary - panellists conveyed and participants echoed the idea that there are scientists who work within regulatory boundaries, then there are people - described as lunatics, maniacs or bioterrorists - who work outside of these regulatory boundaries.

This is another way in which the synthetic biology dialogue was deliberated as a transboundary issue. An employee who went home when an Ebola lab was closed down was a case of someone doing something “that’s not supposed to happen”, rather than someone being a maniac or bioterrorist. This intentionality was a variable in how different actors in synthetic biology were framed in deliberations. This employee was trained in scientific protocols, however they went beyond the boundary of the scientific protocol when they literally went beyond the containment boundary of the building.

This indicates that boundaries between those considered legitimate scientists and those who are lunatics or bioterrorists, are blurred. The rationality of scientists in risk assessments has rightly been questioned (Fischer 2005), however scientists who fail to follow protocols were not considered the same as bioterrorists or lunatics in deliberations.

‘Crossborderness’ and sovereignty

While the method of synthetic biology dialogue used in case study two may serve as an example of upstream engagement for Australian science and technology policy, does ‘crossborderness’ (Zhang et al. 2011) render any eventual Australian regulation powerless? Upstream participatory engagement seeks to empower citizens, yet what role do foreign citizens have in the affairs of US commercial enterprises such as J. Craig Venter’s Synthetic Genomics Incorporated? If a technology proves to be disruptive and changes how we think, upstream engagement is unlikely to generate important outcomes, as critics of upstream engagement have argued (Tait 2009). Rather than abandoning hope for upstream engagement, this supports the case for iteration as an important aspect of meaningful public participation (Powell and Colin 2008). However questions about how methods of deliberative public engagement with science interact with methods of regulation remain and are beyond the scope of this thesis.

Case study three: Deeply transboundary timeframes

The Nuclear Citizens’ Jury was framed as a local issue in the sense that participation was limited to locals in South Australia, although it was a transboundary issue temporally and from a regulatory perspective. Methods of deliberative public engagement with science are methods of participatory governance which must interact with legislative methods of governance. What are the implications of national

sovereignty on global issues, or on state issues such as the storage of waste in South Australia?

The need for national legislative change to take forward recommendations from the Nuclear Citizens' Jury in South Australia were noted throughout the process. A juror on the first day of deliberations articulated questions regarding legislative change and where a new regulator might be placed amid legislative and political boundaries:

“...what would need to happen to be able to start debating at state and federal level to change the current legislation? How would regulation be enforced? It would be free of government involvement? And then to that then how could the regulators be regulators, particularly if you're talking this sort of money. Overall, how do you actually maintain that integrity?

...:In terms of trust, how could we trust future politicians to not change policies that may be put in place as part of this process? How could an independent regulator be free of government or industry intervention and then remain completely independent?” (Spark and Cannon 2016a, p64).

The South Australian Premier responded to jurors at the conclusion of the Nuclear Citizens' Jury that legal action was needed to allow gathering of more information they requested: “there's some further investigations that we need to undertake, and that we might have to change the legislation to give ourselves permission to do that” (Spark and Cannon 2016d, p347). These legislative boundaries differ from the political boundaries in which the Premier has power. Thus differing legislative and political boundaries were another way in which the third case study was in reality transboundary.

Clarifying boundaries about who should count in the Nuclear Citizens' Jury decisionmaking was explicitly discussed by one of the expert witnesses on the second day:

“The second big question in ethics is well who counts? Who should be given relevant consideration to this? Do I just look after myself as an individual, or do I take account of my family, my community? And there are some traditions, particularly in the indigenous community in Australia that gives ethical relevance to everything that exists; animate and inanimate is invested with a significance. And you have to think about how you draw the boundaries when you are thinking of these issues as to whether or not you are going to take a radically egalitarian view in relation to all humans. Whether other forms of life are going to be taken into account, or whether or not you’re going to have a narrower view?” (Spark and Cannon 2016b, p116).

This ethical discussion was presented by Simon Longstaff from the Ethics Centre in Sydney, who then discussed Rawls’ (1999) veil of ignorance. He explained to participants that the veil of ignorance involved looking into a future in which you do not know where you will be born, whether you will be rich or poor, “indigenous or non-indigenous” (Spark and Cannon 2016b, p117).

On the third day of deliberations, participants spent time clarifying between social, regulatory and operational questions (Spark and Cannon 2016c, p139). On the morning this clarifying discussion happened, between 10:39 and 10:46 in the transcript specifically, undocumented deliberations were noted on the transcript as being off the record. This undermines principles of transparency emphasised as important throughout the process, including the jury’s principles listed in the resulting report. The transcript recommenced with an unidentified expert saying the off-the-record discussion was about an “unlikely scenario” (ibid, p14), to which a juror responded: “It’s comforting at the moment but I mean this thing goes for a 100 years”. This demonstrates how the temporally transboundary nature of the issue challenged expert reassurances about probability and certainty.

Off-the-record discussion was followed by discussion about the safety of storage containers for nuclear waste, particularly during transport, as well as whether nuclear waste would be sitting above ground before being moved underground. Transport of nuclear waste to a storage facility from its source overseas is clearly a transboundary issue. A juror asked an expert witness on nuclear waste transport to specify which “significant points” and biggest risks in the transport process they should consider (Spark and Cannon 2016c, p145). These points may be situational, for example if a storage container is on a truck involved in an accident, or geographical. Each point in a geographical transport trajectory is another site in which local deliberations could happen, consistent with Young’s (2006) conception of decentred deliberative democracy. A representative sample of South Australians was asked to consider this entire transport path; they documented as a principle involving other South Australians in future iterations of deliberations, given their clear inability to represent all communities.

Jurors deliberated about the quality of different countries’ nuclear waste storage containers. While the siting of the nuclear waste storage is an issue for South Australian communities, as a juror noted “when the material is in transit it’s going to have to be packed obviously at the source site, not the destination” (Spark and Cannon 2016c, p148). Jurors contrasted Finland and Korea in considering what materials might be used to make containers, given Finland’s advanced nuclear storage research (Kojo 2009). An expert then introduced international regulators as a solution to come of the jurors’ concerns.

“JUROR: So if, say, South Korea or whoever, is shipping it to us, then they have to pack it into the container.

DR VAN CAMP: Yes. JUROR: How do we know that that is a robust container?

DR VAN CAMP: It still has to pass the International Atomic Energy Agency and all of their guidelines. So there's that over - - -

JUROR: Yes, but who's in charge of that?

DR VAN CAMP: The International Agency?

JUROR: Yes.

DR VAN CAMP: A bunch of scientists and engineers and - - -

DR GREEN: United Nations.

DR VAN CAMP: Yes. Like, it's multifaceted.

JUROR: (indistinct) there's an international standard.

DR VAN CAMP: Yes.

JUROR: But it mightn't be our standard, Australia's standard, and - - -

DR VAN CAMP: I would suggest that it's very closely aligned. We can't do anything unless we meet the standards of the International Agency. So it's dovetailed. We have to meet their very high standards.

JUROR: Yes, but you can't guarantee, say, for instance - I'm not trying (indistinct) say (indistinct) you know, North and South Korea. How do we know - - -

DR VAN CAMP: It won't be North Korea, by the way. It won't be North Korea.

JUROR: No. How do we know that they are going to actually do that particular standard?" (Spark and Cannon 2016c, p149).

Transboundary regulatory agencies were presented by an expert as a solution to the impossibility of local control over storage of nuclear waste before its arrival in South Australia. Jurors questioned what people this transboundary agency actually represented, whether scientists, engineers or the UN. How local Australian standards

compared to these international standards and whether they could be equally enforced was information the jury asked for but did not receive in detail during deliberations.

In response to discussion about the risks of breached standards, an expert said there was too much uncertainty to give jurors information they wanted.

“I know those levels of details are wanted, but it's, you know, what is in there? How long has it been in there? Is it just one container? There's so many unknowns that it's not actually helpful to give a distance when we don't know what we're dealing with.” (Spark and Cannon 2016c, p151).

Another expert witness was then called to further discuss risks in transport and storage. Confidence and uncertainty were raised in introducing jurors' questions to the expert who was presenting to the jury via telephone:

“...how can we be confident in international standards around storage, containers, specifications for concrete and materials? So just some uncertainties about how we can be confident on that.” (Spark and Cannon 2016c, p153).

The poor telephone connection meant hearing the expert was difficult, further challenging jurors' ability to access the information they were seeking. Uncertainty and lack of information were clearly a problem in jurors' attempts to deliberate about safety and risks in the transport and storage of nuclear waste. This was not related to their lack of ability to understand information. It was inability to actually access information, due to poor connection with an expert via phone, as well as the unavailability of information due to conditions of uncertainty.

Geological discussions had clearer boundaries and were able to be grounded in local information, both temporally and spatially. Experts discussed the wealth of publicly available data on geology in South Australia, as well as seismic stability. Relationships

between geology and hydrology of the Great Artesian Basin were discussed with less certainty. The transboundary nature of the water basin was discussed. A juror added information shared by an expert, who said the basin extended to Queensland, “JUROR: From Papua New Guinea, I thought. DR HILL: Yes, that’s exactly right. Yes, these are big basins” (Spark and Cannon 2016c, p157). While the local geology of South Australia was an area of science about which high certainty existed relative to other issues discussed in deliberations, uncertainties in impacts on water remained.

Norms of scientific knowledge in deliberating about the geology and hydrology of the region were evidenced in a juror saying they were biased in introducing other forms of knowledge. As discussed in Chapter Four, Young (2002) advocated for inclusion of more diverse forms of communicative action than rationality, including narratives. A juror - one of only 11 from rural South Australia represented - shared some of their personal experiences in discussing the value of water.

“I’ve been there and I’ve had to put a bore down and (indistinct) pull out like they get (indistinct) Artesian bore. The outback Australian, not the city people, live on Artesian bores. We used to be a country where you lived off the sheep’s back, right, and I’m sort of like thinking about where I lived, right, and what we depended on... Maybe I’m biased because I’ve lived in the (indistinct) my eldest son’s father died from radiation poisoning 25 years ago so I (indistinct) massive deformities. My eldest son-in-law is now dead. I’ve lived on a sheep station up near Broken Hill. My husband (indistinct) radiation, he died 12 months ago tomorrow so I’ve seen and it has affected my family so maybe I’m a bit biased but I’ve lived on the land.” (Spark and Cannon 2016c, p158).

The juror highlighted boundaries between city and country people and the lived experience of making a borehole in justifying sharing their narrative. Their emphasis on the different lived experiences of people relying on Artesian bores for water reflects the

value of discursive representation. While participants were selected for representativeness based on demographic characteristics, their choice to nominate to be part of the jury related to a diversity of life experiences. Like participants' diverse perceptions of local scales in case study two, participants in case study three had diverse perceptions about what being local meant in relation to potential nuclear waste storage sites.

Discussion returned to geographical boundaries, with jurors considering whether a nuclear storage facility could be sited somewhere within the state that did not impact the Great Artesian Basin. A juror contrasted certainty expressed by another about dimensions of a storage site with uncertainty given the timescale over which the site would operate.

“JUROR:...The size of Adelaide oval. We're not taking, think it's going to be 20 square kilometres. We're talking an area of about maybe one square kilometre maximum.

JUROR:...is that spot on?

JUROR: (indistinct) storage is going to be for a hundred thousand years. We can't say how the earth is going to be like in a hundred thousand years so how do we know, say for instance we have a big earthquake or some sort of disaster, could actually place up through central Australia like (indistinct) years and years ago. We don't know that and apparently (indistinct) sea level.

DR HILL: That's right, yes.

JUROR: So therefore if we do have something - - -

MS LAMBERT: So how do we deal with uncertainty I guess?" (Spark and Cannon 2016c, p159).

This reflected a trend in deliberations in the Nuclear Citizens Jury where someone would try to ground information in certainty, based on some temporal, geographical, political or regulatory localisation. Another juror would contrast this local framing with

a temporally transboundary frame, pointing out that we do not know whether the same would be true later in the lifecycle of nuclear waste. The deep time necessary for nuclear waste storage means that transboundary uncertainty can be a communicative action challenging any local framing. Political and regulatory uncertainties included discussion of future world wars or unforeseeable governance changes. Certainty about geological boundaries was contrasted and challenged by uncertainty in other boundaries.

Discussion

A juror reporting back to the large group in the Nuclear Citizens Jury summarised some questions pertinent to case studies beyond nuclear:

“how do you measure consent? Should we have a referendum on this issue? That was one thing. Another thing was the timeframe. People felt that they didn’t want to be rushed so to get consensus and to have people educated there should be no pressure and that the timeframe should be, like it should be lengthy so people shouldn’t feel rushed. Also, I guess it goes back to that consultation, face to face consultation is better than screens and handing out pamphlets as well.” (Spark and Cannon 2016c, p169).

How these questions might be answered depends on local or transboundary framing. For example, if there were to be a referendum on this issue, would it be at the state level rather than nationally?

As discussed earlier in this thesis, referenda are part of Australian democracy. There have been referenda in other Australian states, such as one in Tasmania about a dam on the Franklin river, in which a forced choice between two dam sites led to more than a third informal protest votes (Hill 2002; Krien 2012). South Australia has not yet had any local referenda. As the Tasmanian example shows, however, referenda involve specific

framings of issues that may not reflect people's' preferences. Referenda, while a method of full inclusion in voting, do not necessarily involve full inclusion in deliberations leading up to voting.

If there were to be some decision, at what time point would it happen? Nuclear waste storage is a deeply transboundary issue temporally; decentred democratic deliberations across many sites both geographically and in time would reflect this. However given growing problems of nuclear waste storage internationally, action now would have different consequences from actions in 20 years. Jurors concluded more information about what countries would commit to contracts to pay for a nuclear waste storage facility was needed for their decisionmaking. This politically transboundary aspect would involve different information now than in 20 years. This is also true for genomic and synthetic technologies studied as cases one and two. Actionable outcomes depend on access to information; relevant information is time-dependent, particularly in emerging technologies and for policymaking.

The importance of political, legislative and economic boundaries has been discussed in this chapter, as well as geographical and temporal boundaries. This chapter has argued that being clear about what local frames are relevant is a way to promote transparency and accountability. Though as Wynne (2007) argued, STS work should also be mindful of broader political conditions. Jasanoff (2013) used climate change as a case study of an international environmental issue, critiquing a ruling about the responsibility of states to take action on such issues. She interpreted Justice Scalia's judgement in *Massachusetts v. EPA* as possibly saying

“even if world scientific authorities decide there is a supra-national problem out there, the United States government can still continue to administer our

laws as written, even if doing so evades, or even contradicts, the global understanding.” (Jasanoff 2013, p446).

This implies a frame in which, as Jasanoff said, the possibility of knowing something about the global environment only arises through national legal and administrative determinations. This makes sense for accountability, given that we lack agreements about accountability at the global level. It does not make sense for the question of how to act on issues beyond the bounds and laws of states.

Actionable outcomes may depend on local framings, but only if local framings are consistent with international realities. In the case of synthetic biology, does it make sense to say that the science and applications of this technological development are only known if Australian laws and regulations determine they exist? Australians can learn about this by searching the internet. Australians’ ability to use synthetic biology products, should they exist, may well be regulated by national laws that come into effect once reaching our borders. Scientists’ ability to research synthetic biology can be regulated by our laws. However, like climate change, synthetic biology is something that will now still exist even if policymakers and publics ignore it.

Learning from research about transboundary crises management can inform governance in emerging technologies. A crisis is a threat perceived to be “against the core values or life-sustaining functions of a social system, which requires urgent remedial action under conditions of deep uncertainty” (Ansell et al. 2010, p196). This is relevant to synthetic biology given its common framing as a biosecurity risk (Mukunda et al. 2009). As discussed so far, transboundary can be defined across different dimensions, including time, politics, geography and functional boundaries. Ansell et al. (2010, p196) also gave examples of functional boundaries, including a financial crisis crossing into an

industrial crisis when the credit crunch damaged the United States automotive industry, and a private crisis crossing into a public crisis in the case of an oil spill. This private to public crisis is an example of a potential transboundary risk of synthetic biology, as well as the geographical transboundary risk a participant articulated during the forum.

Case study three demonstrated the challenges of representative participation in a locally-framed issue. The Nuclear Citizens' Jury, while limited to South Australians, was not deliberating on a local issue. Representative participation for an issue with so many transboundary dimensions saw jurors declare as a principle the need for further deliberations to include more, ideally all, South Australians. Each point in a geographical transport trajectory is a site in which local deliberations could happen, consistent with Young's (2006) conception of decentred deliberative democracy.

The scale of South Australia as a boundary for framing decisionmaking was too big in some senses and too small in others. It was too big to allow meaningful participation of all communities, particularly communities that would be disproportionately affected.

Local deliberations as part of a decentred democracy strategy in the future may address this. It was too small to give representatively legitimate recommendations on Australian legislative changes required to move forward. South Australians as recipients of nuclear waste would not be in control of how waste would be stored for transport to the state.

Relying on international standards for this involve trust that other countries would abide by international laws, despite breaches in Australia discussed in deliberations.

The second case study was framed nationally rather than at a state level, but found similar concerns about trust in new or existing regulators at international levels. Like the third case study, the second involved high degrees of uncertainty and many unknowns. While in the second case study unknowns were more related to the upstream

stage of technology development, unknowns in the third case study were related to the long life cycle of nuclear waste, about which there is existing information to access.

Transboundary framings reflect upstream public engagement, as was clear in the second case study. The third case study was more complicated in that it was framed as a local issue, with strong organisational ownership by the Government of South Australia. It was upstream in the sense that these deliberations foreshadowed others, but downstream in the sense that relevant questions about whether nuclear waste should be generated are now closed: the waste exists, so deliberations were about actions to deal with it.

The first case study was likewise downstream, in that participants were deliberating on research already proposed, framed and organised by presenting scientists. The deliberative voting method iterated in three instances across two states could, with sufficient resources, be extended to full inclusion. Given that participants framed their decisionmaking about local benefits, iterations of deliberations in different areas would support a decentred democracy strategy.

Results from three case studies presented in this these had different frames for decisionmaking. More participants in the first case study framed their decisionmaking around local outcomes rather than global outcomes. This was evidenced in qualitative responses to an open-ended survey question about why participants voted the way they did. These local outcomes were both spatial and temporal. For example, temporal location was evidenced in several participants explicitly mentioning ‘short-term’ in their decisionmaking, in contrast with a single participant who referred to ‘long-term’. Spatial location was evidenced in several participants mentioning Australia, or specific places like South Australia or the Murray Darling Basin.

In contrast to the first case study, decisionmaking in the second case study was transboundary in a geographical sense, evidenced in discussion about bioterrorism research in the United States and whether there was benefit in discussing synthetic biology in an Australian forum given people could order biological parts on the internet. The transboundary nature of the second case study was also evidenced in similar outcomes from this study and the European SYNBIOSAFE study (Schmidt et al. 2008). While some of these differences between the case studies emerged from deliberations, they also emerged from the different designs of the studies. This reflects differences between deliberations designed for upstream or actionable outcomes discussed in the previous chapter.

The third case study was a temporally transboundary issue, framed in a local way geographically. Deliberations were specifically about South Australia's involvement in the nuclear fuel cycle, with impacts on future generations explicitly discussed in the jurors' report. However this nuclear fuel cycle is transboundary, because while uranium is mined in South Australia, it is processed and used as fuel overseas. Whether or not South Australia should store nuclear waste on behalf of other countries who used it as fuel was core to deliberations. Although it was framed as a local decisionmaking process, for example recruitment for participation was limited to citizens of South Australia, it faced challenges typical of transboundary processes. Participants reported they needed more information, such as whether other countries would cover the costs of developing the infrastructure, to make their decision. It was an upstream decisionmaking process because there were high levels of uncertainty, despite the extensive findings of the Royal Commission.

A deliberative public engagement with science process has more legitimacy as part of a decentred democracy strategy, even though further deliberations may reduce the accountability and actionable outcomes of earlier processes. The Nuclear Citizens' Jury was described by the Premier of SA in introducing it as a precursor to further deliberations. A finding of the jury highlighted safety in the transport of waste as an issue needing further attention. This chapter argued that each point in a geographical transport trajectory should be considered a site for local deliberations to happen. Public engagement at each of these points with linkages between them supports a decentred deliberative democracy strategy. It is then important to make sure that each community's voices are valued, especially given diverse perspectives about what is meant by local in relation to potential nuclear waste storage sites.

This chapter has explored the impacts of local or transboundary issue framings on tradeoff choices. Any issue can be discussed through local or transboundary frames; this chapter has demonstrated some of the diverse frames through which issues can be viewed. Given the diversity of potential frames, being transparent about what framings are considered relevant to intended outcomes and what information organisers thus provide access to is important.

Chapter Eight: Conclusion

This thesis has argued that, while areas of consensus exist about what constitutes good deliberative public engagement with science, some of these areas are contradictory and are better presented as tradeoffs. Three specific tradeoffs were ordinal in the sense that the first relates to recruitment, the second applies in process and the third relates to outcomes. Specifically they were tradeoffs between representation and inclusion, tradeoffs between public and organisational ownership and tradeoffs between upstream and actionable outcomes. Though ordinal in a deliberative process, they should all be considered in the design stage of any deliberative public engagement with science process.

As well as presenting and discussing methods and results of three case studies, this thesis has analysed them through the lens of tradeoffs. These case studies were of deliberative public engagement with science happening in Australia. The first two case studies were examples of deliberative voting methods, while the third case study was an example of a citizens' jury method. This thesis also argued that no standardised method of public deliberative engagement is appropriate for all cases. Considering local contexts is essential. However certain types of deliberations suit some contexts more than others.

Jasanoff (2003, p242) argued that learning from civic deliberations needed to be about “designing avenues through which societies can collectively reflect on the ambiguity of their experiences, and to assess the strengths and weaknesses of alternative explanations”. As analysis of case studies in this thesis has demonstrated, collaborative

reflections on ambiguities and alternatives were more prevalent than consensus decisions or binding outcomes.

Full inclusion is only practical for local issues. Including a specific group in the public sphere is practical for transboundary issues, particularly for promoting decentred democracy as advocated by Young (2006). In such circumstances, upstream outcomes are more likely than actionable ones. Methods designed to explore the imaginations and normative assumptions of a particular group are more appropriate than ones aiming for an actionable outcome, which might lead to frustration among the group if action is not the result. It is important that such processes have linkages with others (Hayward 2008), to help develop mutual understandings beyond specific groups.

The value of tradeoffs and forced choices

This thesis has argued for the value of tradeoffs in interpreting criteria for good deliberative public engagement with science. In describing five tensions for public engagement with science, researchers stated their hope that being transparent about their frustrations putting ideals into practice would be useful for others,

“not only for anticipating difficult terrain (by providing a clearer picture of contested context within which one will have to make choices) but also for helping to find and create alternative routes through the landscape.”
(Delgado et al. 2010, p840).

Focusing on three tradeoffs in this thesis aimed to further clarify the picture of what choices need to be made when putting theory in deliberative public engagement with science into practice.

Forced choices such as tradeoffs are cognitively demanding. Gregory (2002, p462) discussed the nature of tradeoffs in research about community-based environmental risk decisions.

“Many trade-offs, particularly in the domain of environmental and health risks, are difficult to address because they bring up emotional, moral, or ethical issues that are fundamentally hard for individuals to think about and do not easily lend themselves to resolution.”

Chapters in this thesis have analysed normative and substantive values underpinning different ideals in theory, such as representative and inclusive participation. For example, representative participation values rational discourse; inclusivity values equity - both values are ideal. However making rational discourse a condition of participation can exclude some people. Including everyone regardless of their communicative action can undermine rational discourse. Thus it is important during design phases of deliberative public engagement with science that such choices are made with purpose and then transparently communicated.

Learnings from the case studies

The first case study in this thesis was a more downstream deliberative process than the latter two, given that participants were voting on research proposals already developed by scientists. Participants did not decide what direction the research should take - rather they expressed preferences about which research directions should go forward. It was midstream engagement, in the sense it gave scientists the opportunity to incrementally modify their research plans in response to public engagement. This voting on a preference between three options contrasted the latter two case studies of upstream engagement, which yielded questions for further engagement rather than answers on which to act.

Different types of outcomes emerged from the three case studies presented in this thesis, in a pattern that did not correspond to methods used. An outcome from the first case study was consistent preference for one research proposal from three presented. The second and third case study resulted in lists of priorities for future deliberations and action. Given that the first two methods were deliberative voting, while the third was a citizens' jury, this indicates the type of outcome did not depend on the method. Rather it depended on how information was presented to participants and what they were asked to do with it.

In the first case study, participants were asked to use the information to make a forced decision between three options. They were then asked to rationalise their decision in an open-ended question, as well as answer questions rating the proposals on various criteria, to see whether their explanation of why they voted the way they did was consistent with their rankings. This forced choice and rationalisation involved trading off the merits of the research proposals against one another, leading participants to consider their values and articulate their reasoning in prioritising one over another.

The second and third case study did not require participants to make forced choices and explain their rationale. Some findings of this thesis, such as the importance of local framing, depended on this forced choice presentation of information. While such forced choices involve strong organisational ownership and less capacity for participants to frame issues for themselves, it does allow participants to express their preferences and their own reasoning, which promotes collaborative learning through transparency.

In contrast to case study one, in which participants were individually asked to share their reasoning as well as voting together, in case studies two and three participants' communicative actions were brought together in presenting a single outcome. Outcomes

depended on mutual understanding developed through communicative actions during deliberations. Any individual meanings and reasonings participants may have used personally in decisionmaking were not reflected in the resulting lists of priorities. This made it more difficult to analyse what communicative actions contributed to outcomes.

Case studies two and three did have instances in which participants used their power to express reasoning that was not evident in the outcome documents. For example, in case study two, a spokesperson from a small-group discussion communicated to the large group that an expert influenced their small-group deliberations. Whereas other small groups had followed organisational norms in deliberating about policy priorities, the group in which an expert scientist participated had less focused deliberations.

In case study three, jurors communicated about issues including the rights of traditional owners and the potential for solar energy as an alternative investment strategy, which were not detailed in the resulting report. During deliberations, participants' communicative actions are inevitably more extensive than those captured in resulting lists or recommendations. This thesis has argued which communicative actions generate enough momentum to be reflected in outcomes reveals organisational frames that are stronger than public power.

Case study two differed from the first and third in that participants voted on attitudinal questions at three time points during the forum. E-voting technology was used to reveal these votes live, which increased transparency, but may have impacted deliberations and outcomes in unexamined ways. For example, an early poll about attitudes to science and technology showed nearly half of people in the room thought science had mostly positive impacts. This was reflected in a majority voting positively on synthetic biology research into biofuels, medicines and soil remediation.

These early findings may have led participants who had voted more neutrally to change their communicative actions, in seeking to arrive at mutual understandings. The 55% of participants who indicated that science had both positive and negative impacts may have changed their communicative actions in response to realising nearly half the people they were interacting with did not perceive negative impacts of science. Participants may have used information generated in the course of the forum, about the perspectives of those they were deliberating with, to change their communicative actions. This will be discussed further in recommendations for future research.

Participants in all of the case studies were analysed for demographic representativeness, however some scholars have argued discursive representation is more important in deliberative public engagement with science. For example, a civil society report about synthetic biology described the technology as extreme and advocated for the precautionary principle (Hoffman et al. 2012). This perspective was not well represented, if at all, in the second case study's deliberations.

In the third case study participants shared lived experiences related to deliberations, for example the experience of relying on water from the Great Artesian Basin, close to where a nuclear waste storage facility might be sited. Such perspectives add to the argument pool from which participants develop mutual understandings. More diverse experiences and perspectives increases opportunities for collaborative learning, given learning depends on available information. Discursive representation allows participants to collaboratively learn from information shared through participants' experiences and perceptions, as well as information presented by experts or organisers.

Using the framework of tradeoffs in design

Most issues can be framed as either local or transboundary; how an issue's boundaries are framed can be used as a basis for deciding between the tradeoffs. Understanding the situation in which a deliberative process is happening is precursor to making decisions about the three tradeoffs presented in this thesis. Wynne (2007, p109) argued that STS work should seek to understand political and economic dimensions of techno-sciences; these dimensions can be considered boundaries, alongside temporal and spatial ones. In designing a deliberative process, being clear about what boundaries one is working within indicates what outcomes might be achievable. On which scales deliberative outcomes could have impact informs understanding of which tradeoffs might be appropriate.

Being clear about the boundaries of a process helps with recruitment and with transparency and accountability, as well as deciding on what information participants will base their deliberations. Framing an issue at a sufficiently local level supports inclusive participation; full inclusion in any single deliberative instance is not possible with transboundary issues, so representative methods may be more appropriate.

Alternatively, engaging with a specific group can be part of a broader decentred deliberative democracy strategy. This may be more appropriate particularly in contexts in which representative methods may struggle to demonstrate legitimacy and accountability.

Information used to frame deliberations is important. In the first case study, participants were presented with three research proposals presented by scientists who wanted to action them. In the second case study, four researchers presented more generally about synthetic biology from perspectives of scientists, lawyers and ethicists. In the third case

study, participants heard from expert witnesses who had also contributed to the earlier Royal Commission, about which their deliberations were focused. What information is used indicates a project's framing, which must be considered in trading off public and organisational ownership.

Processes with strong organisational ownership have clear options or information sources for deliberation, as seen in case studies one and three. This leaves little opportunity for participants to question norms and assumptions embedded in a process, or to engage with ethical questions. However, such processes may be more accountable, given whichever organisation was responsible for access to information should also be responsible for accountability. Public ownership of outcomes is typically a goal of processes initiated by organisations, though rarely is public ownership a focus of the process. The impact of publicly generated information in case study two, in the form of voting outcomes, was not anticipated and warrants future investigation. Whether outcomes are actionable or upstream emerges from the information used as much as the deliberative process, given it is upon information that people develop mutual understandings.

Upstream engagement and anticipatory governance are popular concepts in deliberative public engagement with science, however this thesis has argued that upstream outcomes are a tradeoff against actionable outcomes. This depends on whether one considers an outcome to be something that emerges from a process or something that happens in response to it. All deliberations are action and a feature of deliberative processes is collaborative learning, a valuable outcome for participants. Framing outcomes as emergent from a process means that methods can yield both upstream and actionable

outcomes, due to changes in participants themselves. If participants are part of organisations it can also lead to organisational change.

However framing outcomes as what happens as a result of a process, rather than during it, leads to a tradeoff. Methods focused on actionable outcomes tend to be further downstream, when there is less uncertainty and complexity so decisions can be made with greater transparency and accountability. Upstream outcomes reflect participants' imaginations and collaborative learnings and can deal with ethical and normative questions that may influence developments deeply in future; however this is not guaranteed. There are risks that upstream engagement, which tends to yield more questions than answers, may simply frustrate participants and have no policy influence. These risks reflect the uncertainty inherent in upstream deliberative processes.

Reflecting on areas of consensus in theory beyond tradeoffs

There is strong consensus about the value of learning outcomes in literature. Learning should be an outcome of a deliberative process itself, as well as potentially a later outcome of documentation of deliberations. Collaborative learning and the development of mutual understandings is core to deliberative public engagement with science. While most public engagement with science is concerned with learning, deliberative public engagement with science is distinct for its focus on collaborative learning and mutual understanding.

Jasanoff (2003) discussed concerns with what was learnt, not just that learning happened. Outcomes in case study two may have been impacted by extra information generated by participants in the process. This extra information from voting was not argumentation and deliberative discourse - it was data generated from it. Whether

incorporation of voting outcomes impacts collaborative learning could be a future area of research.

Fair deliberation is challenging to evaluate and evidence, linked to transparency and accountability. Transparency in documenting ways in which deliberations may not have been fair is arguably more effective than arguing for a process's fairness. Case study three was transparently about South Australia's involvement in the nuclear fuel cycle, so alternative energy options were out of scope. The accountability of the process could have been undermined if deliberations had gone in this alternative direction. So assessing the fairness of deliberations depends upon transparency and accountability criteria.

While fair deliberations, transparency and accountability were presented as areas of consensus by Chilvers (2008a, p159), their interpretations differ among scholars. Some of the different ways these ideas can be understood have been analysed in this thesis. For example, the second tradeoff of public versus organisational ownership is related to accountability as well as independence, listed as a distinct area by Chilvers. In a more recent list of design principles analysed in the introduction, independence was referred to only within review (Dietz 2013, p14083). Dietz's principles embedded the principle that agencies organise deliberations, as is typical for invited engagement. Independence was not identified as a criteria during process, but rather the need for independent review or collaborative inquiry with interested parties was emphasised.

Recommendations for future research from the case studies

Deliberations of different groups

The first case study was a proof of concept for the idea that members of the public can make decisions about funding using similar values to those of experts or policymakers. However, whether these decisions might have differed from those of experts was not explored. A variation could involve using the same method to elicit decisions from groups of policymakers and experts, as well as groups of public participants. Then public voting patterns could be contrasted with expert ones. The acceptability and credibility of such a public method for making decisions could be influenced by understanding similarities or differences between voting outcomes depending on who decides.

Linking public deliberations with crowdfunding

As was noted in Chapter Six, participants deliberating about science funding as a research experiment is different from participants' deliberations about science funding actually resulting in research funding. If the aim were for genuine public decisionmaking about science funding, a more actionable outcome would be for the process to generate actual rather than theoretical research funding. Crowdfunded science has emerged this century in fields including medicine (Siva 2014) and ecology (Wheat et al. 2013). Public participants could buy tickets to a deliberative event that covered costs of incentives such as meals, but also included some extra funds for research. A research funding agency could match participant funding for a research project, thus supporting public participation in research funding decisions. This may appeal to members of the public who do not have the funds to be venture capitalists on

their own but would enjoy the opportunity to be more involved in research funding decisions.

Research proposals presented by lab to explore presenter impact

The first case study aimed for diversity among experts so involved three scientists of different demographics presenting their own research proposals. Future experiments could group demographically similar researchers together to present proposals, reducing variables of gender, age, and ethnicity. To test whether such variables do affect decisionmaking in this model, three labs with internal diversity could work together to present a research proposal from each lab. The same proposals could be presented by different researchers within the respective labs at different events. Regardless of how this affects voting outcomes, participating scientists may enhance their science communication skills through seeing the same proposal presented and received via diverse perspectives. Actively acknowledging diversity and its role in decisionmaking may also improve participants' satisfaction (Abdel-Monem, Bingham, Marincic, and Tomkins, 2010).

Exploring impact of seeing votes during process on deliberations

In contrast to the first case study, in which people expressed their attitudes on surveys, results of which were not made public, the second case study used e-voting technology that made results transparent to all participants in real time. This may have affected people's' participation. For example, upon seeing that 45% of participants thought science has mostly positive impacts on society, the 55% who were neutral may have changed their behaviour. Knowing information about fellow deliberators' attitudes may have changed some participants' communicative actions and argumentation.

As well as information presented by experts, participants in the second case study had another source of data to inform their deliberations and communicative actions: polling results as their deliberations unfolded. In future studies with several iterations of deliberations, half could have the transparent voting process, while half could keep the voting outcomes private, to test whether this impacts deliberations and voting patterns.

Reconsidering boundaries for who can participate

The third case study had well-defined boundaries for participation. There is no doubt that informed consent from landowners where a nuclear storage facility might be built would be explicitly needed; what is less clear is who else should be involved in decisionmaking. South Australia was a colonially demarcated zone; nonsensically given geographical placement, what is now Australia's Northern Territory was once administratively part of South Australia (Donovan 1981). These state borders have defined who is eligible to be part of the Nuclear Citizens' Jury, an example of how representative methods of recruitment for deliberations can be problematic. Given a nuclear storage facility would be far from the populated coast in the more geologically stable outback, would random sampling for recruitment be more appropriately from central Australia?

For deliberative public engagement with science, such bioregional boundaries (Hutchinson et al. 2005) could be more appropriate than political colonial ones.

However it is the Government of South Australia that invited participation, as part of a policy to reform democracy. Thus it is those within this governance boundary who were invited, participating within the organisational frames through which their participation was designed.

Deliberations about alternative renewable energy policies

The third case study was the first in a series of deliberations about South Australia's involvement in the nuclear fuel cycle. Participants in the deliberative process studied and in the broader public sphere have called for exploration of an alternative renewable energy investment strategy for South Australia. Substantial funds were invested in the Nuclear Citizens' Jury process, including the Nuclear Fuel Cycle Royal Commission which cost \$7.2 million (Weatherill 2016b). Though the same level of investment may not be feasible, deliberative public engagement about policy alternatives based on other science applications, such as solar thermal energy, would be valuable given communicative actions of jury participants.

Given the criteria of accountability, it is reasonable that the Nuclear Citizens' Jury sidelined discussions about alternative investment pathways, as their role was clearly to discuss the potential of deeper South Australian involvement in the nuclear energy cycle. Had they recommended investing in solar rather than addressing nuclear waste storage, the outcome would not have reflected the objectives. As was noted during deliberations, South Australia already invests in renewable energies including wind and solar. They are not mutually exclusive policy options. However which policy options receive funding for deliberative public engagement with science indicate organisational norms.

The above two paragraphs were written before final revision of this thesis, at which point recent developments in South Australia can be included. In the year since the Nuclear Citizens Jury, funding for a solar thermal facility in Port Augusta has been secured (Rice 2017), as well as a world-leading battery facility to store energy from wind and solar (Kozioł 2017). I am not the only one to suggest that the outcomes of the

Nuclear Citizens Jury gave the government confidence to support alternative energy innovations. An opinion piece discussing better democracy said the “no” result of the Nuclear Citizens Jury did not mean it was unsuccessful.

“This alternative logic is that the democratic process delivered. The nuclear jury educated citizens about the magnitude of ambition the state must have to realise a new era of prosperity.

In saying “no” to nuclear waste storage it documented the importance of renewable energy to the state’s clean and green image. This gave licence to pursue an ambitious renewable energy proposal, which government has now done.” (Ryan 2017)

As discussed elsewhere in this thesis, it is notoriously difficult to evaluate outcomes of deliberative processes, given lack of evidence of causation as well as the range of other factors at play in policymaking. In this case, after jurors repeatedly requested non-nuclear alternatives be considered, the organization that commissioned the deliberative process took action in delivering some alternatives. No-one would argue it was an outcome of this deliberative process alone. I was among many amplifying voices of communities in and around Port Augusta making the case for a solar thermal plant there. Many forms of communicative action in support of solar thermal at Port Augusta, ranging from protests in Adelaide outside parliament to letters in newspapers and to leaders, shaped the broader public sphere in which these options were considered.

Linking subsequent investment in alternative energy technologies to the Nuclear Citizens Jury depended upon transparent documentation of deliberations, not simply objectives and outcomes. This revealed repeated instances in which jurors chose to discuss alternatives and put them on the agenda, which was not well captured in the Royal Commission report, nor in the framing and information formally presented to

participants through the process that led to the jury's report. This is an example of how transparency can facilitate evaluation of deliberative processes.

Putting theory into practice

Demand for advice about how to put theory into practice led to Appendix 2 of this thesis, a list of questions for practitioners of deliberative public engagement with science. Considerations underpinning these are discussed below.

As Chapter 6 has discussed, there are a range of outcomes from deliberative processes ranging from upstream learnings to binding recommendations for action. Most evaluations have been focused on the processes of single events, and are usually done by event organizers rather than people observing the broader political context (Rayner 2003). Demonstrating success is contingent on defining aims and objectives that can be evaluated. Useful questions that can be evaluated include who are you seeking to include in your deliberative process? What is the aim of the process? The process can be aimed at reaching a specific decision on a given topic or providing consultative input for strategy planning. Those processes aimed at reaching a specific decision are easier to evaluate for accountability, as the process of reaching the decision and then acting on the decision can be made transparent (Smith and Rowe 2016).

Though there is consensus around principles of best practice, it remains challenging to evaluate the success of deliberative processes. Evaluating individual principles, such as demonstrating fairness, is an achievable goal for evaluation (Martin et. al. 2002; Tenbensel 2002). For Chilvers (2008), fairness is about people being able to express their views and develop mutual understandings. Fairness is related to process and representation as well as individual participants' experiences. Knight et. al. (1997) call

fair process procedural equality, and quote Kenneth Arrow (1977) in outlining three conditions for the enforcement of procedural equality in deliberation.

The first of these conditions is unrestricted domain, which means that people reflecting all interests were able to participate in reaching deliberative outcomes. As discussed in Chapter Four, who participated is an important consideration; how participants were recruited should be evaluated for fairness and representation. Besides the democratic value of equal opportunity to participate, diverse perspectives allow participants to learn from each other and consider the broader picture (Delli Carpini et. al. 2004). On the other hand, heterogeneous groups can require more facilitation and individuals may gain less satisfaction from the process (Stewart et. al. 2007). Single representatives of particular views may not be enough to level potential power differences within deliberation; an individual may feel intimidated if other perspectives have greater representation in a group (Martin et. al. 2002; Stewart et. al. 2007).

There can be tension between unrestricted domain and the expectation that all participants commit to reasonable discussion, which John Rawls emphasized for effective deliberation in his Theory of Justice (1999). It can be difficult to reconcile diverse viewpoints to reach agreed outcomes. Organizers can be accountable for procedural fairness and fair representation, but fairness during deliberations also relies on the mindset of individual participants. Good facilitation supports effective communicative actions among deliberators, but attitudes and behaviours of participants are their individual choices. Bruni et. al. (2008) argued that representation is not as important as having a diversity of fair-minded people who can articulate a range of values, arguing for discursive representation as discussed in Chapter Four. Daniels (2000) described fair-minded people as “those who seek mutually justifiable grounds

for cooperation”, who “must agree that the reasons, evidence, and rationales are relevant to... the shared goal of deliberation” (ibid, 1301). However, as discussed in this thesis drawing particularly on the works of Young (2002), insisting on reasonableness can exclude people with valuable perspectives.

Before excluding people perceived as biased or irrational it is worth considering how transparent processes and good facilitation can encourage a fair and co-operative mindset among participants. Powell and Colin (2009) argued that all citizen engagement projects should include capacity building and training for citizens; people should not be expected to instinctively know how to deliberate effectively. On the other hand, as discussed in Chapter 5, organizational or cultural change within institutions may be required for meaningful deliberations, rather than putting the onus to learn new skills on public participants (Newman et. al. 2004). As discussed in the introduction, Young (2006) explored how oppression can be inherent in a process or organization. Without conscious planning to enforce fair-minded attitudes, deliberation involving laypeople and experts may give rise to criticism of laypeople’s credibility and legitimacy (Milewa 2006). A part of procedural fairness and facilitation is working to eliminate or at least minimize inequalities between participants so that arguments, not individuals, are the subject of scrutiny and the cause of persuasion. Asking how power imbalances can be minimized during planning stages is recommended and included as a question in Appendix 2.

Minimizing power differences and inequalities involves allowing time for advance preparation and discussion of information during the deliberative process. This enables people to build their confidence in decision making and supports the expression of divergent views. Clearly defining participant responsibilities can also increase

participant confidence and process fairness (Gibson et. al. 2005), reflecting the principle of transparency. Allowing people to abstain from making a final decision reinforces the acceptability of divergent views. While consensus may be ideal, transparently recognizing that a final decision is agreed but not endorsed by all participants can be preferable to a consensus reached by a process in which power imbalances were overlooked.

Following unrestricted domain, the latter two of Knight and Johnson's (1997) conditions for procedural equality are focused on the obligation for organizers to promote fair-mindedness among participants: namely anonymity and neutrality. Anonymity means that the deliberative procedure must treat all participants equally, regardless of characteristics such as socioeconomic background or religious affiliation, to use Knight and Johnson's examples. Thirdly, neutrality requires that the procedure not favour a particular outcome; this condition is linked to accountability and the importance of transparent aims and objectives. These conditions demonstrate why deliberations with people defined as stakeholders rather than citizens struggle to demonstrate fairness, as discussed in Chapter Four. If participants are recruited as stakeholders, such as representatives of patient groups or religious movements, it is more difficult for them to reason and deliberate as individuals open to different arguments, as they have come to the deliberation representing a particular position. Similarly, it may be more difficult for other participants to consider the arguments or preferences of others fairly, knowing others are representing different interests to their own, as defined through their stakeholder status (Smith and Rowe 2016).

There has been little published on the policy outcomes of participatory deliberative events, aside from scholars lamenting the lack of evidence in this area (Tenbensel 2002;

Contandriopoulos 2004; Mitton et. al. 2009), and criticism of event planners who fail to consider outcomes in the first place (Powell and Colin 2009). Knight and Johnson (1997, 292) believe it would be “next to impossible” for any deliberative process to embody the procedural equality they outline. Rayner (2003, 167) notes that a general problem in evaluating outcomes is the inability to establish a causal link between the process and its outcomes. Deliberations that lead to decisions unacceptable to policy makers could arguably be evaluated as failures (Webler 1995). On the other hand, if public deliberation resulted in a decision aligned with the pre-existing preferences of policy makers, what evidence is there that deliberation was actually useful and relevant, more than a mere formality? This is why a complexity outcomes have been explored in Chapter Six.

Discussion

Governing and being governed

Describing Aboriginal Australians as being invited to participate in state affairs is a controversial frame given contested history of invasion and resistance (Reynolds 2006). Australia’s cultural context may not suit the language of Wynne’s (2007) model of invited and uninvited participation. As Arnstein’s (1969) ladder of participation demonstrated, there are many steps between full citizen control and manipulation, some of which are tokenistic. Participating in governance may not feel like a choice, particularly when potential paths have been closed down through past injustices.

Hayward (2008) argued that decentred deliberative processes can help to address anger and give voice to communities whose local perspectives may otherwise be excluded from transboundary issues. This thesis has discussed how demands for rationality in

communicative actions (Habermas 1984) may be unreasonable, given the roles of emotion and narrative in arriving at mutual understandings (Young 2002). It is especially important to hear and value communicative actions of groups that have suffered past injustices; linkages between outcomes of deliberative processes in such communities supports meaningful deliberative democracy (Hayward 2008).

This question of boundaries and power is also relevant for case studies in emerging technologies. Participants in the second case study expressed powerlessness given that synthetic biology was transnational and Australian policy seemed futile. Researchers of relationships between the FBI and DIY biologists reported that for DIY biologists, engaging with the FBI was not an option but a necessity (Tocchetti and Aguiton 2015, p837). Tocchetti and Aguiton argued that openness and transparency values of DIY biologists extended to collaboration with the FBI (ibid, p845). This transparency was one-way communication, given that open science communities share information in ways that closed science communities, such as defence-funded synthetic biology in Australia, do not. Deliberative democracy depends on information in the public sphere. Deliberative public engagement with science happens in the public sphere - communicative actions in private spheres do not contribute.

South Australians as nuclear citizens

This thesis has discussed framing of the NETS-PACE project as enabling technologies, of which the second case study was part. Enabling technologies could conversely be framed as uncertain technologies. So far, the title of the third case study, the Nuclear Citizens' Jury, has not been addressed. The title can be understood as a jury of citizens about nuclear; alternatively, it can be understood as a jury of nuclear citizens. This title is an example of why place is important (Young 2002; 2006; Hayward 2008).

This thesis has argued that if a deliberative process is independent from an organisation it is seeking to impact, there may be no actionable outcomes. Accepting the reality that organisational ownership dominates invited methods and being transparent about impacts of this is more likely to result in actionable outcomes. Public ownership is supported by including people with power to organise for change in a process.

Wehling (2012, p43) argued that uninvited types of participation have greater impact. Uninvited types such as protests or boycotts tend to be in reaction to organisational framings, thus are designed to impact them. For example, a Tasmanian referendum about damming a river was presented as a forced choice between two dam sites. This resulted in more than a third of voters registering protest votes that typically said “no dams”. A referendum on South Australia’s role in the nuclear fuel cycle was proposed by a juror during deliberations; this suggestion was not taken forward.

Uninvited participation in the form of protests happened alongside the first day of the Nuclear Citizens’ Jury, but rather than contrasting communicative actions, protesters articulated the same concerns as jurors in the invited deliberative process. For example, a media report quoted a protester’s concerns about waste transport and impacts on future generations.

“I’m really worried about what the implications of this long-term dump are going to be, and how it’s going to affect us for the rest of our lives and for generations... How are they going to get it here? There’s so many things that can go wrong.” (Waldhuter 2016).

Narratives of uninvited participation outside the Nuclear Citizens Jury reflected deliberations inside. The formal process was organized by the South Australian Government, particularly the Royal Commission and range of experts presented to

provide information. However, participants engaged in deliberations about issues beyond those articulated in the Royal Commission report, reflecting the concerns expressed in uninvited participation, suggesting some public ownership. Though the process was focus on nuclear futures, there was strong awareness of South Australia's existing nuclear history –South Australians engaged as nuclear citizens not by democratic choice, but by colonial circumstance.

Instead of a referendum following deliberations of a representative population sample, the next steps of the Nuclear Citizens' Jury process were town hall meetings across the state and a subsequent second citizen's jury. Decentred, iterative invited participation arguably reduces the risks of protest actions, given that communicative actions of protesters may be included in outcomes of invited processes.

Remaining question

The question of who should be decisionmakers in science policy was an outcome of this thesis; it was a question raised rather than answered. This uncertainty is rich in both potential and risk. A benefit of upstream deliberations is the potential for alternative visions and new possibilities to emerge. Despite the absence of certainty, policies are made and technologies are developed. Questioning how and by whom is a mandate of STS research, as Wynne (2007) argued. Given this question emerged as a finding, answering it is beyond the scope of this thesis.

In presenting some areas of consensus as tradeoffs, this thesis aims to make deliberative scholars and practitioners evaluate their assumptions about best practice. Tradeoffs help practitioners to make decisions in design that they will otherwise have to navigate in process. Forced choices in design encourage reflection on values. Rather than

considering tensions that can be balanced, this thesis has argued some design choices are tradeoffs.

Tradeoffs involve turning away from some possibilities and embracing others.

Transparency is crucial so that others are able to turn towards that from which organisers have turned away. Future iterations of design choices may be able to prioritize that which was missing before. Decentred deliberative democracy is about linking forums and sites where different values, resources and stories have been prioritized in different ways. This thesis has linked three case studies as stories drawing on different values and resources. These contribute to decentred democracy in Australia and the emergence of deliberative public engagement with science globally.

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Appendix 1

Synthetic biology: What does it mean for you?

**AS = Alan Saunders (Facilitator), E = Experts (Claudia, Alison, Desmond, Rachel),
F/M = Unidentified audience member (female/male)**

[Transcript non-expert discussions starts: 1:30:32]

AS OK ladies and gentleman – since we’ve been discussing the ethics and the financial ethics of biotechnology and synthetic biology, we should perhaps mention our own funding body; the Royal Institute of Australia is very grateful for the funding from the Federal Government through its national enabling technologies strategy. Now at this stage, we have twenty minutes, if that’s what it takes, general questions from the audience and discussion and then I’ll re-poll you using your click pads and there’s a hand – lady in the blue, already up.

F Yes I want to ask – [AS: Hang on there’s a roving microphone] Thanks. I want to ask a technical question; you talk about ordering DNA synthetic DNA, where does this come from? I presume they don’t start with atoms of oxygen, nitrogen, phosphorous etc. Are they taking DNA from some organism and chopping it up into the triplet code and putting these together, and if so, where do they get it from? This is a technical question, where’s it come from? Isn’t it DNA that comes from a living being in the first place?

E [E] That’s a great question [E Claudia: That’s a very good question] and actually your presumption that wasn’t the case it is the case, so you’re starting with individual chemicals and building the what we call the nucleotides, or the building blocks of the DNA the ACG and T that you’ve probably seen at one stage or another, and that’s actually what you feed into the machine, An ACG and T which is a collection of chemicals with a particular structure and you add those one by one by one by one. And that’s it.

AS Where do they get them from?

References

E Well they get from well I mean oxygen comes from the air and carbon comes from a variety of different sources, maybe it comes from the sucrose that we use in the sugar cane, nitrogen comes from – well most of the nitrogen that we use for fertilisers and such forth comes from bird guano, and various environmental sources so if it's not coming – broken down from a living organism basically.

AS Yes no living beings were harmed in the making of this experiment. The lady next you, in red.

F2 Yes we were discussing things and then we realised we were discussing them on a national level how this might be controlled, and it seems to us that it's much broader, this is international there are no boundaries, when you can order it over the internet, are we just wasting our time even discussing this here because can someone in some remote country do something with anything we might say or believe, matters?

AS OK yeah who wants to take that one? I'm sort of looking at you Rachel.

E Yeah I'll saying something – so I think yeah I think it sort of falls to me. Yes somebody in some remote country can and may well be and probably is doing something that looks like it's kind of research but I still think there's warrant to talk about it here because we have scientists, who do research and public dollars are going probably to funding it and so on and so on. So it's not just about control over the finances but about what we want as a society our scientists to be doing. What we think the good outputs are. How they should be doing it not telling them how they should do their work but what kinds of controls do need to be in place. I in some ways, it's my personal opinion think, the bioterrorism concerns are very real and yet almost completely uncontrollable and so I think that's in a way kind of the least of the issues. The bigger issues are what are the priorities, do we think this kind of stuff that Claudia's doing is doing – is a useful kind of output for our tax dollars? I mean to put it in a very blunt way.

AS OK I love the idea that biotechnology is the least of the issues, [E: Bioterrorism] sorry bioterrorism, but only because it's the one we can't control. Thank you for those words of comfort. There's another lady over there.

References

F3 Hello, I guess what I'm asking is there was a little bit of talk about unknown unknowns, known, unknowns and what sort of research has there be done in the known/unknowns, unknown/unknowns, because to say there are unknown/unknowns seems unusual given the fact that were examples about how they can be syntho-biotechnology to be done to assist with malaria. So there must be some sort of research into the known/unknown and unknown/unknowns.

AS Well I think it's in the nature of things that you can't research unknown unknowns because you don't know anything about them, but what about known unknowns does anybody?

E I will take a crack at this one

F3 [*Off mic speaker*] unknown unknowns...researching that area.

E Exactly right.

AS Well you might know if there's something out there that you don't know and you don't know that you don't know it but...

F? But bioterrorism is...it's uncontrollable therefore? [1:36:04]

E So that's correct. There are people trying to research into unknown unknowns and I think that the strongest example of that at the moment is in the US where there is extremely active anti-bioterrorism research so there are some incredibly good people and very good labs racing like crazy to think up weird and wonderful ideas that the nutters out there might be thinking up themselves and finding ways to mitigate against that and every time you go through the airport in America you're probably reminded of that, you're constantly reminded when I go through ?[1:36:37] airport in the States. So it's – I guess I have to give you some security or some reassurance that nothing – that something is being done and that people are thinking and actively, really actively working in that field. On the side of what do we not know and what could become of this technology, well it is always the case that someone will use the technology for something that we can't foretell so Oppenheimer said when he saw I think it was Trinity he looked at it and he said, "I have become the destroyer of worlds." It was something that he did not really anticipate could happen even though he was working in an

References

extraordinarily powerful technology. So it – there will always be something that we cannot control, that we cannot predict, but we have to take that with the positives that come with the science and the technology.

F? [Off mic inaudible]?

E Yes so there's an enormous move at the moment towards what we call systems biology which is basically holistic biology looking at even individual biological cells and systems and not just individual genes, DNA, bits of protein and stuff but as entire systems and measuring those systems and the technologies that we now have to do that are really amazing as well and we do wonderful science with that and then putting those individual organisms and cells inside an environment and having them interact and looking at that as a system and an entire ecosystem and so on and so forth, larger and larger. So there's a real move towards that at the moment, yeah.

AS OK I've seen a lot of hands from this side of the floor, anybody – nobody has – oh yes, yes you sir?

?M [1:38:27] bioterrorism issue – presumably there's this horrible dangerous organism that you could create using this technology – the Americans would have already discovered it.

E [Rachel] ?[1:38:38]

M So should we just wire up all this labs in the world in just wire it up to the US Defense Department and if the research seems to be going into a dangerous direction they could just press a red button and it just eliminates

E [Rachel] ?[1:38:50]

M Lap. And then the rest of us don't have to worry. This sort of Centralised Bureaucracy solution I suppose.

AS I don't know who is the most American – it's you Desmond. Don't you think it's all to do with the State Department?

References

E [Desmond] Well I don't have an American accent. Sorry I'm not sure I understand the question so you're saying are the Americans doing something to, to control bioterrorism or...

AS Create it I think is what you were saying?

E [Rachel] It was more like a comment wasn't it that if I understood you, probably it's quite likely the Americans have created these things and so probably quite likely they have the antidotes in a way Claudia was talking about?

M I wasn't thinking – the antidote is just to kill the scientist who liked they were about to discover it.

AS Yeah.

?F Right. That's actually really bad because

E I agree I really support that statement.

AS You heard it from a lawyer.

?F I don't kill people.

AS OK we don't want to kill people. There's – you...

?F Yeah my question was really about the development of synthetic biology and where it's heading, you said that it's sort of being helped along by the increased development of DNA sequencing and technologies like that. Me working in that sort of area I know that the current bottleneck of that is analysing all this massive dialect that can be created, do you think that is something that is going to be also progress quickly along with or is that going to take a while for us to overcome?

E Yeah...

E Definitely Desmond's area, he's a scientist.

E [Desmond] Yes I mean I guess yeah I mean I do a lot of computational work and you know so I mean clearly there's a lot of data being generated and how we cope with

References

the mass of data, and kind of make sense of it – you know is a real challenge. The fun thing is that – say you look at sequences you know how much it DNA sequencing can be done and how much have we recorded – the so for example converting that to models and organisms, that's actually kept up more or less with the rate we're producing the sequences so the technology to sort of turn what we're getting into something that has some sort of human meaning to it is actually developing in pace. At least – you know that's just one example. I tend to think that the computer guys are pretty smart I mean [laughter]

E Yes there's an entire field of research; bioinformatics, devoted to how do we handle these enormous data sets, how do we make them talk to each other and talk to us as scientists, how do we draw patterns out of them and yeah the computer guys are pretty good at that.

AS OK now we have to move on quickly because the scouts want the use of the hall, gentleman in white, final question.

M Thank you I tend to be a bit of a positive person so I'd like to talk about the benefits but I think in this debate it's clearly – the benefits are obvious so it's the harms that regulate the whole discussion so and that seems to come down to the magnitude of the harms and the potential mitigants against them and I find myself thinking back, this has happened before, we've explored new technologies and we've got our fingers burnt and then we've learnt how to harness those technologies but we still occasionally have sparks that ignite parks – if I can use the fire analogy. Growing up it takes a while 'til you learn that point, you know lighting the candles on a birthday cake if you start on the other side you're not going to burn your hand as you get closer but there's an educational component to that. Where are we on the scale? Because around fire we have enormous amount of knowledge as a species, around this we have very little knowledge – can you share some of the examples of things that have gone wrong, some of the near misses, some of the things that keep you guys awake at night because I think it's only when you actually understand the difference between burning a can of petrol and climate change, there's a scale to these things that we need to get into place in order to assess the quality of those benefits against them.

References

E OK so that's a really great question and there's two parts I'm going to address the two parts separately. The first is – learning from our mistakes, and I'm going to come at this from the scientist point of view so I have a background in agriculture and engineering so the whole genetically modified plants thing and when we were going this in the 80's and 90's and such forth, we were all sort of fired up about this wonderful stuff that we were doing and really excited about how we were going to make food for the world and we were going to save people in developing countries which were called Third World countries back then but you know it's all PC nowadays and we were really passionate about the science that we were doing and then people were unhappy about it and we were a bit sort of miffed that they weren't excited 'bout it too. And we kind of went on and did it public they'll get over it, they'll move and they'll understand but they didn't. and we learned from that we did actually learn from that that was really an entirely wrong approach, that we have to be accountable for the research that we're doing and as we said, it's public funding that's been spent on the work that we're doing, and we have to be able to explain why and how we're doing it and the public has to be happy with that. and so what I find really amazing about this debate that we're having tonight, that we've been having all week now at various different locations is that here we are addressing an issue in Australia, the science is barely getting started yet but we're already dealing with the legal, ethical aspects of it that are so very important. So I'm really heartened by that and then I think that's a really important and wonderful thing that we're doing. So that's the first part of the comment that I want to say. Now the keeping awake at night thing – I actually don't have things that keep me awake at night. Maybe somebody else can share some examples?

E [Desmond] well I was just going to say I mean I don't think that it is completely new in that we do have a long history of considering biosafety and biosecurity. You know there is in labs – we have protocols in place for containing potentially hazardous organisms and every now and then you do hear about near misses. So you know where I used to live in Boston, there was what is called a Biosafety Level 4 lab, which is very, very rare, most cities don't have them. In Boston there is one which is in downtown Boston which is very unusual but you know those are the kinds of labs where they do work on Ebola they do work on sort of you know highly infectious agents, and yeah there was one year – it made it into the paper, they had a fire or something and then they

References

had to close down the building and then one of the employees was working in a
?[1:46:02] level 4 just went home and you know that's not supposed to happen. Right.
So there are – there are complete protocols in place, people who work there have to
train for a long time to work in those labs, and you know we do have some experience
in containing organism and making sure they don't get out, you know out of the lab.

AS OK so we can all sleep safely in our beds tonight. We're now going to re-poll
you now let me remind you that you have your little clicker pads. You can't click until
the 10 second count down starts and when you have clicked the little pad will light up
and tell you ...?[1:47:12]

[Polling/questions follow]

[Break-out groups]

[2:46:27 til end] Open audience discussion

[Transcript starts]

AS [2:47:35] what about the – I'm going to pick a colour that's exactly what I'm
going to do – the purple group – what has your spokesperson got to say for him or
herself? About the issues that concern you?

M OK I get to be first so you can all say "Oh he said what I was going to say."

AS By the way you've got about a minute.

M OK. That's fine I can talk quickly. Three policy issues, top three policy issues.
One of the first ones we came up with was the issue of who decides what happens with
synthetic biology research and application of research in Australia. There is a lot of
thought about information expert groups involving industry and scientists and so on [?F:
Slow down a little bit...] OK I'm Scottish, I talk fast. So expert groups were thought of a
potential body to help decide what happens with synthetic biology. Public servants it
was decided that they just don't have the knowledge to be able to do what's required but
there was a general consensus that politicians should be given charge with what happens
with synthetic biology because not only are they – they're accountable. Doesn't matter
what you say about scientist and industry people they are not accountable for what – for

References

the decisions that they're not going to put to the public and that's the important thing. The second policy issue that we came up with was the issue of safety and control. We had a lot of discussion about the organisms that are created are replicating or non-replicating. That has a lot to do with – especially if you're talking about using these things for things like soil remediation if you're throwing things out into the environment the issue whether they can self-replicate is a big one. Replicating organisms are efficient but they're not controllable, non-replicating ones are not as efficient but they are controllable. But that spilled over into thoughts whether there should be a specific ethical framework that's in place when universities decide what research is done on synthetic biology. The third issue was risk and benefit analysis. When do you decide a particular application of synthetic biology has better benefits than the potential risks and this brought up the dual use issue again. And when should you decide whether a new application of synthetic biology can be used for evil and what can you do about it. So those were the top three that we came up with.

AS OK three issues there were they held in common by any of the other groups? I'm looking for the other groups' spokespeople? Hello no? No they seem to be unique. Unless somebody is not bringing themselves to my attention? No. So do any of our presenters want to comment on these concerns? We'll get a few more right. Hello – sorry. Which one of you?

F We're the Coasters.

AS Oh okay the Coasters will be fine.

F Which was not our coast but what we were...

AS Yes.

F OK amongst our group we had great discussion. There was agreement that there was great potential in this but we focused on dealing with potential problems. Because we said there will be problems and there will be failures and the unknown unknowns are real. So what we saw as the first policy issue is that we want transparency nationally and internationally and the sharing of information to minimise the risks of that and to make sure that there's national and international knowledge to be able to respond.

References

Which leads us to our second major point that we believe that there needs to be a policy to have a rapid response capability initially nationally and leading to internationally so that problems can be dealt with and there could be a monitor of what's happening and people could be brought into place fairly quickly to deal with it and the third was that we believe that there need to be policies that make practical regulations, they need to be consistently evolving in terms of recognising the potential and the developments that were taking place. Those regulations and we cheated we put a whole lot into one; were to have national priorities the whole idea that when governments fund particular enterprises, a large amount of the money raised should go back to the funding body and we need practical regulations so that scientists have that horrible word 'certainty' – they know what they can undertaken and what they can't undertake.

AS OK did any other group have – you had the same

M We had one the same.

AS Which one was...

M Transparency, sharing of information – just – that was a subset of we wanted a regulator who had a big picture view, a systemic view, a holistic view, and we wanted full disclosure. We took the analogy at least I did – of the nuclear industry where you might have regulatory framework but you've clearly in some countries had lapses in disclosure so we wanted some smashing – or certainly I wanted some smashing of people who failed to disclose, so people had a – there was an evolving view being built. Should I continue with the other two that we had that didn't match?

AS Yes which group are you by the way?

M We're the Greens.

AS OK yes carry on with your other thoughts.

M We wanted a focus on the building blocks as well. The... we talked about yeah sure you can get it from overseas but whether it was controlled or some analytics capability knowing what was flowing to where and some degree of oversight of transport – we drew the analogy again of uranium, saying it's quite easy to regulate big

References

drums of yellow cake it's a lot harder to regulate small sachets of DNA product. But some attempt we thought whether that's registration approval or just monitoring of websites and the like. And finally we wanted some examination of intended use, so some auditing along the way and we understand there's already some checks against known pathogens but that obviously needs to be something that evolves. Understanding there may be some commercial in confidence issues in there. Interestingly there was no desire to actually prohibit any behaviours. I think there was to prohibit any behaviours – I think there was a general view that there was no value in doing that it was – it would be ineffective anyway so.

AS OK the first point was held in common with the Coasters – the other two points did anybody else have concerns in that area? No in that case we will move swiftly on – to the Blues. Where's the Blues' spokesman – there he is.

M OK there have been some things – some overlap with the concerns with other groups – written in the form of questions. Who will have access to information about these technologies and the potential impacts so for example will the information be public? Another one is – who will decide how the technologies are regulated and whose advice will they take when they're making these decisions. And thirdly will it ever be possible for the public to have the technology and materials to make synthetic biological organisms and if so should we be allowed to?

AS OK anybody else share that or those concerns?

Nobody's owning up to – oh are you owning up to sharing those concerns

M A lot of overlap on our first one – we're the Gold group.

AS The Gold group – oh okay. Yeah.

M So yeah how to regulate the effect that industry has on policy formation – the double edge I guess sword of the Golden Rule – they who spend the money make the rules. But when we're talking about that we're not just talking about the people doing the research but perhaps lobby groups who have a lot of influence on governments so there's you know obviously there's an unfortunate burgeoning industry and sort of anti-scientific establishment and the Christian Right and things like that so yeah how does

References

that affect regulation. Second one; how does IP so intellectual property law need to change to keep up with the changing pace of tech research? Can a legal and regulatory frameworks be refined to change as fast as the science is changing? There's no point in making the regulation about new science that's coming out if it takes five or six or ten years for it to wind its way through parliament and various committees and things like that. And so how to do that appropriately. And lastly, how does one define a system that asks the right ethical questions at the appropriate time? Is it even possible to do so and especially that produces ethical regulation and sort of the example that we were kicking around was if you find that it's ethical to – looking at the macro level to make drugs that kill malaria, what then happens when you have an extra million people living in a country that doesn't have the infrastructure to support them. Who then asks the ethical question about when it's appropriate to apply those drugs.

AS OK anybody share the concerns of the Golds? No okay let's move on to pink – who's pink? You're pink. Think pink.

M Thanks. We had a random discussion you might say. It was – to some extent assisted by Des, who was very interesting to talk to. So we talked about things other than policy for most of the discussion because it seemed more interesting, but in the last five minutes we came out with really two but then we had to add a third one. We thought that in terms of policy one of the most important things is improving the general public's understanding about synthetic biology – we thought that there should be more education at all levels, including the school children and public discussions like that because unless you kind of have an understanding you can't really have an informed debate about going into the more important nitty-gritty stuff. Second thing we thought while obviously regulation's important, you need to have a discussion about that to find the right balance. You obviously don't want to have too much control but you don't want to have no control so that the complete maniacs do damage. The last area of policy we thought was related to commercial secrecy, trying to break down the barriers so that scientific community has access to some of the innovative breakthroughs that can actually assist everyone. So for the common good. And that was it.

AS OK anybody – yes?

M ?[3:00:07]

References

AS You're yellow – because I've got yellow, gold and orange here I don't know who's who but okay.

M So what's the previous – was it pink yes it was pink. Talking about education very, very important. That was under our first heading of 'Positive Benefits' versus 'Management of Risks'. There is a key thing to think about. So one of the subheadings of this was funding. We were concerned of where it was coming from. and not just from government source and private sources, what are these people want as a return on investment from this funding etc etc etc. The biological outcomes from the research being done. The environmental aspects and as the pink groups say about education if people were more informed they probably would make better decisions for the most part. We were really a bit afraid of exploitation so our second thing was criminal exploitation. We're scared of unscrupulous people basically you know using this technology for a bad way and we tried to think of some ways to regulate the environment in such a way that it's impossible for them or very unlikely for them to get a hold of this technology and to perform those bad acts as it were. The third one, we wanted to keep this separate from the second one for obvious reasons, was commercial exploitation. So the one big case that we were considering, which I didn't know about personally was the Monsanto case which was a definite monopoly based problem and yeah that was our three things.

AS OK I think we might as well now – I think we've just got one group left – Orange? I think they're orange. Yes they are orange.

F So we did share a number of the same concerns that have just been voiced, particularly with the last two groups with the importance of education I think transparency in all research from scientists was important and maintaining public debate and you know through events such as this, educating the public to avoid you know media hype on certain issue, I think it was important to get the real issue out there. One of the other things – the second point we came up with, was again to mention the Monsanto issue that cropped up was that we didn't want monopolies from mega-corporations or even governments having control over such technologies and the third thing we came up which sort of relates to the second point was about who will actually be in charge of security measures and biosecurity, you know will it be a State

References

Government level or Commonwealth or if there needs to be some kind of international regulatory body and how rogue countries will be controlled and even if there will be some kind of even UN involvement with this kind of regulation. So that was us.

AS OK I think there's nobody I've left out is there? No. Does anybody on the panel of experts want to comment on either particular issues raised or the general drift of the discussion?

E Well I guess I'll just raise the point – I'm not hearing I mean when we do the poll and so on, but I'm not hearing out of this a lot of discussion of allowing scientists just to self-regulate. And then hearing [3:03:57] need a fair amount where you – something at a higher level and yet some [3:03:59] it seems like you're complicit or there's a lot about what level that should be and what form it should take. So the devil is in the detail as loads of you have said. And then that breaks down to something differently we need to regulate and we should do it, it seems to be somewhat higher than no regulation at all or self-regulation is something higher. That [3:04:23]...

F That question about who should have control – some of that [3:04:31] and what I want to see [3:04:31] what we discussed formally at our table, is that you have something, [3:04:37] the judiciary so you would have people that would be there at the very – [3:04:42] who would be as the judiciary do with the law profession make decisions about what they're doing and they would be at that level of [3:04:52] And that's wasn't an option we were given unfortunately.

E [Rachel] Public officials might [3:04:57] kind of option, can't even think about it. It's not dissimilar when you describe it, [3:05:01] dissimilar and that's the other thing I was going to say, from the way the gene technology regulator operates now. I liked it. They tend to have some kind of scientific expertise. They consider licences which include information [3:05:16] but they have access to that information. Many people think that that's sufficient because they're only allowed to consider certain sort of [3:05:20] certain sorts of issues. Others think they're not allowed to consider particularly social implications for example. Or which benefit might be a better benefit, they're not allowed to do that according to law. They're only really allowed to consider the merits of the application, are they appropriate safeguards in place that sort of thing. Or when you take from the lab, so on and so on. They're not allowed to consider

References

whether the product's worth having it at all And people don't that's – sorry that was a long answer – that is a very similar mechanism to what you're describing and that would be public official's?[3:06:01].

F I think we were concerned about it being put in to the hands of Sir Humphrey?[3:06:05]

E [Rachel] It's hard to figure out what word?[3:06:11]

AS No... no! Sir Humphrey's just the man you want because he wants anything to change. Any other comments from the expert panel?

E [Rachel] Well what do you guys think about self-regulation...?

E [Alison?] Well self-regulation happens a lot, [Rachel: Course it does] in the industry, it happens not just at the level where the scientists are working but as somebody already commented it happens in the industry itself that's applying us, so if we want to go and order a gene, when it turns up at the company that makes the DNA they'll actually screen it for known toxins so if it encodes a protein that is a known toxin they'll say I don't think so, we're not going to make this for you. Of course that doesn't mean you can't order a toxin they don't know about. But so far that's at least in my circles that's not happening. And I think the reality is that the people who want to do this sort of thing aren't unregulatable [*sic*] in any way so it's not going to be the industry itself, Desmond and I and various other people who are doing it, that are going to be trying to create synthetic biology monsters, it's going to be your bioterrorists that are well outside any kind of regulation that we can apply anyway.

?F Do you think that scientists ?[3:07:30] ethical...? With anyway?

E Yeah I think so – I mean we now – well I should hope so – we're now training – so when we have undergraduates coming through they have the option and are encouraged to do ethics courses. At the undergraduate level as part of their training. So I would like to think that there's a pretty strong ethics that runs through science in general

E [Rachel] But even more pragmatically I mean I'm not so sure of that I think people ?[3:07:59] more pragmatic, sort of what is the currency in science: Publications.

References

You're not going to publish something that is a recipe for bioterrorism and so on and so on. Discoveries that are going to be pragmatically useful and for the most part that's not in turn something that's damaging that – surely you certainly get a rogue scientist now and again who will then go back and use them for some other capacity. But for the most part science functions are being published, incredible new discoveries and so on and science you know as establishment isn't going to tolerate things that are malevolent probably, although you have the Oppenheimer case [3:08:37] World War particularly when scientists say, well I just didn't realise it was going to – and you can believe them or not believe them. there was lots of cases were [3:08:45] immoral purposes.

E [Alison] There are plenty of examples of that I guess in history. Yeah.

AS OK I think we should probably move on to the voting – your final clicker pad poll....anything happening?

F? Two minutes.

E [Rachel] [3:09:16]

AS OK let's do that. Alison?

F? Well I actually ...but whether you think the [3:09:28] gene technology Act is sufficient and in particular talk about what [3:09:33]

E [Alison] Yeah that's not something that I can talk about in detail. I think the gaps so really – at the moment I don't think that that system deals with synthetic DNA and [3:09:51] synthetic organisms but the question of what they should consider sort of is a bit outside what I can comment on but. I think – I don't really [*sic*] heard in the different groups a lot of discussion about when we're talking about who should make these decisions like what they should base the decisions on and how they should get the right information, where should they get it. And also discussion about education and awareness generally so I heard a lot about information, getting the right information, making information transparent so the public can access it as well that was definitely [3:10:33]

References

E Yeah and so I think there is a really – well starting to be a strong trend in the scientific industry of transparency so for example the research funding that we're working on now is 50% of that is put aside for a techno-economic evaluation and a life cycle evaluation. Basically a cross-benefit evaluation as to whether or not the technology that we're hoping to develop is actually worth developing. And so that's going to be available on a public Wiki [3:11:01] for everybody to access if they wanted to have a look at it. The other comment that I wanted to make that follows on from what you were saying in response to the question is there is a fair amount of legislation in place now and there's an Act now that is an umbrella Act which covers that. The technology that we're using now to do synthetic biology is very much technology we've been using for a long, long time. The techniques are the same we're applying it in slightly different ways and my feeling is that the legislation, the regulation that's in place at the moment is very much likely to be sufficient maybe with a bit of tweaking. Sorry I'm being hurried along.

AS Desmond, do you want come in?

E [Desmond] OK apparently not.

AS It's not obligatory. Especially as we now have the policy issues on the screen. And what we're going to ask you to do...

[*Voting*3:12:00 til end]

[END TRANSCRIPT]

Appendix 2

Questions for designing deliberative engagement

This concise list of questions is intended for those planning deliberative public engagement to consider, so designs take into account principles of best practice.

- What is the aim of the deliberative engagement process?
- What political, social, legal and temporal boundaries are relevant?
- Who are you seeking to involve?
- How are you being transparent about recruitment and process?
- How are you deciding what information will be the basis of deliberations?
- How will you support participants to reasonably deliberate?
- How will you minimize power imbalances during the process?
- How will you support collaborative learning and building social capital?
- How will outcomes of deliberations be documented and shared?
- Are there opportunities for revision or iteration of the process and outcomes?
- How can you be accountable for outcomes and reporting back to participants?